QAPP Worksheet #1 – Title and Approval Page

QUALITY ASSURANCE PROJECT PLAN AND FIELD SAMPLING PLAN
Gowanus Canal Superfund Site, Brooklyn, New York
Brooklyn, Kings County, New York

February 2014

Prepared by:
Geosyntec consultants

Review Signatures:

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Howard Cumberland / Date
Team Project Manager – Geosyntec Consultants

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Julia Caprio / Date
Quality Assurance Manager – Geosyntec Consultants

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Ted Leissing / Date
National Grid Project Director

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Andrew Prophete / Date
National Grid Project Manager

Approval Signatures:

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Joel Singerman/Date
Project Officer – EPA Region 2

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Christos Tsiamis/Date
Project Manager – EPA Region 2

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Name/Date
Quality Assurance Manager – EPA Region 2

EXECUTIVE SUMMARY

This Quality Assurance Project Plan (QAPP) and accompanying Field Sampling Plan (FSP) are being developed for the Gowanus Canal Superfund Site (the Site) to accompany the Pre-Design Work Plan (PDWP) under the Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation dated April 29, 2010, as amended on January 24, 2014 (the AOC). A Site Map is provided as PDWP Figure 2-1. The AOC covers only the development of those portions of the PDWP detailed in the scope of work (SOW) attached to the AOC Amendment (AOC Attachment A). This QAPP and FSP are developed as companion documents to the PDWP.

This QAPP and accompanying FSP specifically address sample collection, analysis, and data management methods and procedures of the following pre-design (PD) work elements:

- Additional reconnaissance of the Gowanus Canal (the Canal) bottom for pre-construction debris removal (PD-3, SOW Table 1);
- A plan for debris removal, decontamination, and disposal (PD-4, SOW Table 1);
- A survey and assessment, as it relates to the implementation of the remedy, of the integrity of existing bulkhead along the canal and a determination of the extent of temporary bulkhead installation required for remedy implementation (PD-5, SOW Table 1);
- A plan for staging site selection and implementation of staging operations (PD-6, SOW Table 1);
- Data collection for the evaluation of potential groundwater upwelling at the Canal bottom, including identification of groundwater discharge areas and measurement of discharge rates (PD-7, SOW Table 1); and,
- Evaluation of native sediments in the Canal to identify areas of potentially mobile non-aqueous phase liquid (NAPL) to define the in situ stabilization (ISS) treatment boundaries (PD-8, SOW Table 1).

LIST OF WORKSHEETS

ACRONYM LIST

ATTACHMENTS

ACRONYM LIST

%R	percent recovery
µg/L	micrograms per liter
CA	corrective action
CAS	Chemicals Abstracts Service
CCC	calibration check compounds
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	centimeters
CPT	cone penetrometer test
CSM	conceptual site model
CSO	combined sewer overflow
CU	consolidated undrained
CVAA	cold vapor atomic absorption
DQA	data quality assessment
DQAR	Data Quality Assessment Report
DQI	data quality indicator
DQO	data quality objective
EDD	electronic data deliverable
ft	feet
GC	gas chromatography
GC/ECD	gas chromatography electron capture detector
GC/MS	gas chromatography mass spectrometry
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HNO_3	nitric acid
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma mass spectrometry
ICP-AES	inductively coupled plasma atomic emission spectroscopy
ICV	initial calibration verification
ISS	in situ stabilization
LCS	laboratory control sample
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
LCSD	laboratory control sample duplicate
MDL	method detection limit
mL	milliliter
MPC	methods, procedures and contracts
MQO	measurement quality objectives
MS	matrix spike
MS/MSD	matrix spike/matrix spike duplicate

ACRONYM LIST

MSD	matrix spike duplicate
N/A	not applicable
NAPL	non-aqueous phase liquid
NCM	nonconformance memo
NELAP	National Environmental Laboratory Accreditation Program
ºC	degrees Celsius
OSHA	Occupational Safety and Health Administration
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity
PCBs	polychlorinated biphenyls
PDWP	Pre-Design Work Plan
PM	Project Manager
QA	quality assurance
QC	quality control
QL	quantitation limit
RF	response factor
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RT	retention time
RTA	remediation target area
SDG	sample delivery group
SOP	standard operating procedure
SPCC	system performance check compounds
SSHO	Site Safety and Health Officer
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TBD	to be determined
TCL	Target Compounds List
USCS	United Soil Classification System
UU	unconsolidated undrained
VOA	Volatile Organic Analysis
VOC	volatile organic compound
WS	worksheet

QAPP Worksheet #2 – QAPP Identifying Information

Site Name/Project Name: Gowanus Canal Superfund Site
Site Location: Brooklyn, Kings County, New York
Site No./Code: NYN000206222
Operable Unit: 01
Contractor Name: Gowanus Canal Consultant Team
Contract Title: N/A
Work Assignment No.: N/A
N/A - not applicable

1. Identify guidance used to prepare QAPP:

- Administrative Order on Consent (AOC Index No. A2-0523-0705) dated 29 April 2010.
- AOC Amendment dated 24 January 2014.
- Record of Decision (ROD) signed on 27 September 2013.
- Uniform Federal Policy for Quality Assurance Plans, (UFP-QAPP) (USEPA 2005)
- EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA 2002)
- Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, the American National Standards Institute/American Society for Quality Control Standard E4 (ANSI/ ASQC E4, 1994)
- Guidance on Systematic Planning Using the Data Quality Objectives Process, USEPA QA/G-4
- Requirements for the Preparation of Sampling and Analysis Plans, USACE EM 200-1-3, 2001
- Contract Laboratory Program Guidance for Field Samplers, OSWER 9240.0-44, EPA 540-R-07-06, USEPA 2007

2. Identify Regulatory Program: The work is being completed pursuant to the above-referenced AOC and ROD issued under the CERCLA Remedial Branch.

3. Identify Approval Entity: USEPA Region 2

4. This QAPP is: project-specific

5. List dates of scoping sessions that were held: 08 January 2014, 23 January 2014, 12 February 2014

6. List dates and titles of any QAPP/FSP documents written for previous Site work that are relevant to the current investigation.

- GEI Consultants, Inc., 2005a. Draft Field Sampling Plan, Gowanus Canal, Brooklyn, New York,
- GEI Consultants, Inc., 2005b. Draft Quality Assurance Project Plan, Gowanus Canal, Brooklyn, New York,

7. List organizational partners (stakeholders) and connection with lead organization:

- USEPA Region 2 (lead agency)
- New York State Department of Environmental Conservation (NYSDEC) (support agency)
- Gowanus Canal PRP Group (to be formed)
- Geosyntec Consultants (interim oversight)
- Task Subcontractors (to be determined [TBD])
- Analytical Laboratories (TBD, fixed off-site analytical laboratory)

8. List Data Users:

- USEPA Region 2
- New York State Department of Environmental Conservation (NYSDEC)

- Gowanus Canal PRP Group (to be formed)

9. **If any required QAPP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted QAPP elements and provide an explanation for their exclusion below:** N/A

QAPP/FSP Identifying Information
Required Elements

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross Reference to Related Documents
Project Management and Objectives		
2.1 Title and Approval Page	- Title and Approval Page	WS #1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	- Table of Contents - QAPP/FSP Identifying Information	WS #1 WS#1, WS#2 Attachment A
2.3 Distribution List & Personnel Sign-off 2.3.1 Distribution List 2.3.2 Project Personnel Sign-off Sheet	- Distribution list - Personnel sign-off Sheet	WS #3 WS #4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities & Qualifications Table - Special Personnel Training Requirements & Certification Table	WS #5 WS #6 WS #7 WS #8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs Table) - Project Scoping Session Participants Sheet - Conceptual Site Model - Site History & Background - Site Maps (historical & present)	WS #9 WS #9 WS #10 PDWP and PDWP Figures
2.6 Project Quality Objectives & Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Project Data Quality Objectives - Measurement Performance Criteria Table	WS#11 WS #12
2.7 Secondary Data Evaluation	- Sources of Secondary Data & Information - Secondary Data Criteria & Limitations Table	WS #13 WS #13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Reference limits and Evaluation Table - Project Schedule/Timeline Table	WS #14 WS #15 WS #16

QAPP Worksheet #2 – QAPP Identifying Information (continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross Reference to Related Documents
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design & Rationale 3.1.2 Sampling Procedures & Requirements 3.1.2.1 Sample Collection Procedures 3.1.2.2 Sample Containers, Volume & Preservation 3.1.2.3 Equipment/Sample Containers Cleaning & Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	- Sampling Design & Rationale - Sample Location Map - Sampling Locations & Methods/SOP Requirements - Analytical Methods/ SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing & Inspection table	WS #17 Attachment A PDWP Figures WS #18 WS #19 WS #20 Attachment B WS #21 WS #22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument & Equipment Maintenance, Testing & Inspection Procedures 3.2.4 Analytical Supply Inspection & Acceptance Procedures	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument & Equipment Maintenance, Testing & Inspection Table	TBD WS #23 WS #24 WS #25
3.3 Sample Collection Documentation, Handling, Tracking & Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	- Sample Collection Documentation, Handling, Tracking & Custody SOPs - Sample container Identification - Example chain of custody form and seal	WS #26 WS #27 WS#19 TBD
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples Table	WS #28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling & Management 3.5.5 Data Tracking & Control	- Project Documents & Records Table - Analytical services table	WS #29 WS #30

QAPP Worksheet #2 – QAPP Identifying Information (continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross Reference to Related Documents
Assessment		
4.1 Assessment & Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings & Corrective Action Responses	- Assessments and Response Actions - Planned Project Assessments Table - Assessment Findings & Corrective Action Responses Table	WS #31 WS #31 WS #32
4.2 QA Management Reports	- QA Management Reports Table	WS #33
4.3 Final Project Report		WS#33
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations & Actions from Usability Assessment 5.2.3.2 Activities	- Verification (Step I) Process Table - Validation (Steps IIa & IIb) Process Table - Validation (Steps IIa & IIb) Summary Table - Usability Assessment	WS #34 WS #35 WS #36 WS #37
5.3 Streamlining Data Review 5.3.1 Data Review Steps to be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining	- A specific percentage of data will be streamlined based on project specific requirements	WS #36

QAPP Worksheet #3 – Distribution List

The following persons will receive a copy of the approved QAPP/FSP, subsequent QAPP/FSP revisions, addenda and amendments:

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Joel Singerman	EPA Region 2 Project Officer	EPA	(212) 634-4258	Singerman.Joel@epa.gov
Christos Tsiamis	EPA Region 2 Project Manager	EPA	(212) 637-4257	Tsiamis.Christos@epa.gov
TBD	EPA Region 2 Quality Assurance Manager	EPA	TBD	TBD
Ted Leissing	National Grid Project Director	National Grid	(516) 545-2563	Theodore.Leissing@nationalgrid.com
Andrew Prophete	National Grid Project Manager	National Grid	(516) 790-1654	Andrew.Prophete@nationalgrid.com
Julianna Hess	Oversight Project Manager	CH2M Hill	(973) 316-3520	Juliana.Hess@CH2M.com
Jeff Gentry	Oversight Technical Lead	CH2M Hill	(503) 736-4390	Jeff.Gentry@CH2M.com
TBD	Project Director	TBD	TBD	TBD
TBD	Gowanus Canal Consultant Team Project Manager	TBD	TBD	TBD
TBD	Health and Safety Manager	TBD	TBD	TBD
TBD	Quality Assurance Manager	TBD	TBD	TBD
TBD	Engineering Manager	TBD	TBD	TBD
TBD	Assistant Project Manager	TBD	TBD	TBD
TBD	Debris Reconnaissance and Removal Task Manager	TBD	TBD	TBD
TBD	Bulkhead Assessment Task Manager	TBD	TBD	TBD
TBD	Staging Site Task Manager	TBD	TBD	TBD
TBD	Groundwater Upwelling Investigation Task Manager	TBD	TBD	TBD
TBD	Evaluation of NAPL Migration Task Manager	TBD	TBD	TBD
TBD	Gowanus Canal Field Team Leader	TBD	TBD	TBD

QAPP Worksheet #3 – Distribution List (continued)

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
TBD	Gowanus Canal Field Staff	TBD	TBD	TBD

NAPL = non-aqueous phase liquid
TBD = to be determined

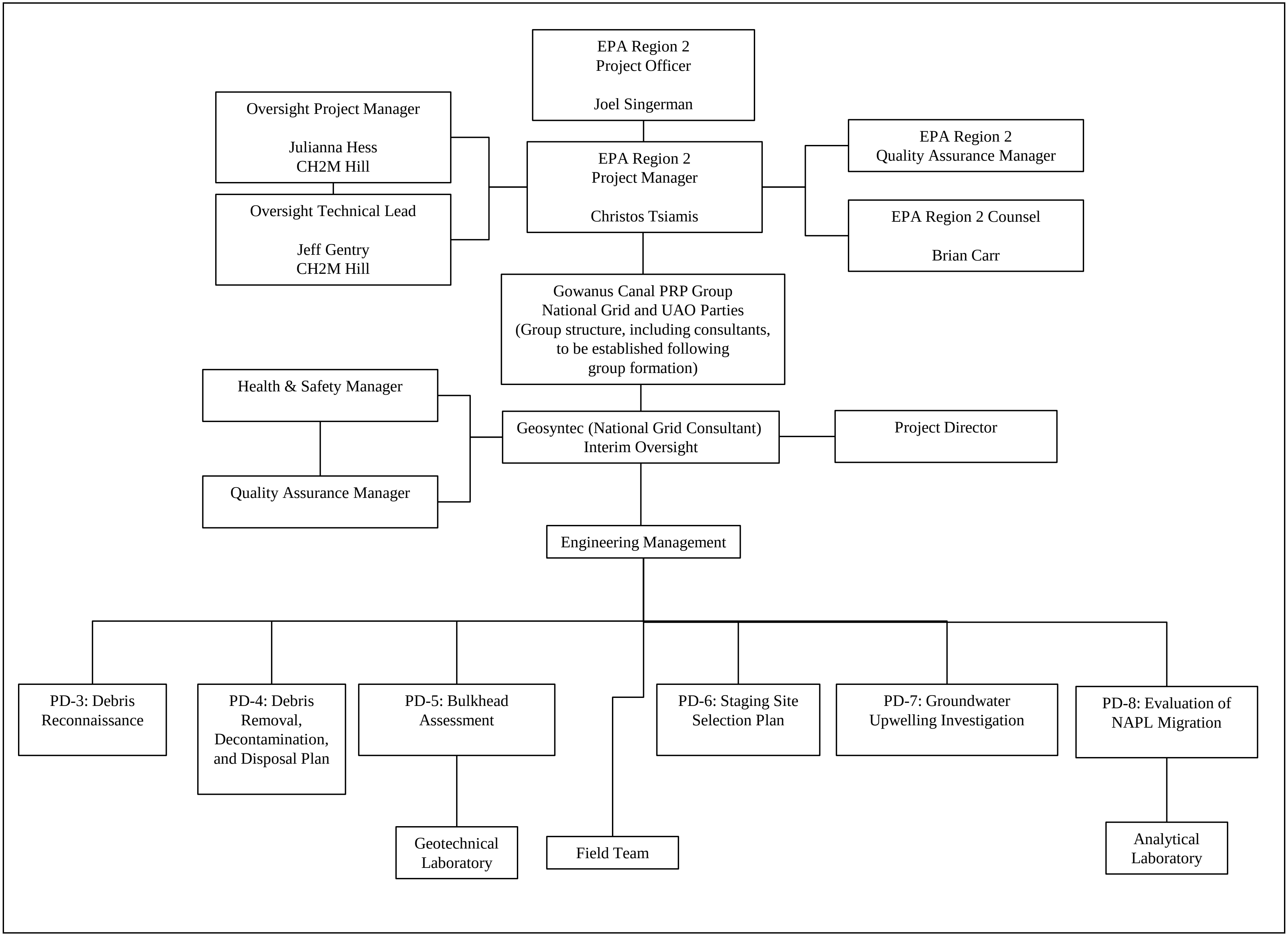
QAPP Worksheet #4 – Project Personnel Sign-Off Sheet

Project Personnel	Organization/Title/Role	Telephone Number	Signature	Date QAPP Read
Julianna Hess	Oversight Project Manager	(973) 316-3520		
Jeff Gentry	Oversight Technical Lead	(503) 736-4390		
TBD	Health and Safety Manager	TBD		
TBD	Engineering Manager	TBD		
TBD	Assistant Project Manager	TBD		
TBD	Debris Reconnaissance and Removal	TBD		
TBD	Bulkhead Assessment Task Manager	TBD		
TBD	Staging Site Task Manager	TBD		
TBD	Groundwater Upwelling Investigation Task Manager	TBD		
TBD	Evaluation of NAPL Migration Task Manager	TBD		
TBD	Gowanus Canal Field Team Leader	TBD		
TBD	Gowanus Canal Field Staff	TBD		
TBD	Laboratory Project Manager	TBD		

NAPL = non-aqueous phase liquid
TBD = to be determined

[1] Signature indicates personnel have read applicable QAPP sections and will perform the work as indicated herein.

QAPP Worksheet #5 – Project Organization Chart for Pre-Design Work Plan



QAPP Worksheet #6 – Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Approval of amendments to the QAPP	Consultant Team	Team Project Manager (TPM): TBD Engineering Manager (EM): TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Obtain initial approval from TPM. Submit documented amendments within 10 working days for transmittal to the National Grid PM for submission to the EPA Remedial Project Manager (RPM) for approval.
Approval of activities deviating from QAPP	Consultant Team	TPM: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Obtain initial approval from TPM. Submit request for deviation within 10 working days for transmittal to the National Grid PM for submission to the EPA RPM for approval.
Document control	Consultant Team	TPM: TBD EM: TBD Quality Assurance (QA) Manager: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All reports and formal correspondence will be reviewed by TPM prior to transmittal to the National Grid PM for submission to the EPA RPM. Documents prepared by TPM for submittal to National Grid and EPA will be reviewed by QA Manager or other team member prior to submittal to the National Grid PM for submission to the EPA.
Stop work and initiation of corrective action	Consultant Team Health and Safety	TPM: TBD EM: TBD	TBD TBD	The TPM will communicate work stoppages to the National Grid PM within 24 hours. Note that all field personnel will have stop work authority if an unsafe condition is

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
	(H&S) Manager Site Safety and Health Officer (SSHO)	H&S Manager: TBD SSHO: TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	encountered.
Real time modifications, notifications, and approvals	Consultant Team	TPM: TBD EM: TBD	TBD TBD	Real-time modifications to the project will require the approval of the EM and TPM and will be documented within 5 working days.
Reporting of health and safety issues	Consultant Team	TPM: TBD H&S Manager: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All H&S issues involving an injury, a "near miss," or a condition that may result in an incident must be reported to the H&S Manager immediately. The H&S Manager will forward this information on to the TPM using telephone and email as soon as possible. The TPM will notify the EM or designee, who will notify the National Grid PM and EPA RPM of any serious health and safety incident/issue within 24 hours of occurrence. Non-serious incidents/issues may be forwarded from the EM to the National Grid PM who may submit to the EPA RPM on a monthly basis within the monthly progress reports.
Reporting of issues related to ROD requirements	Consultant Team	TPM: TBD EM: TBD	TBD TBD	All serious issues will be reported to the TPM and EM immediately.

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Community relations	EPA	EPA RPM: Christos Tsiamis TPM: TBD EM: TBD National Grid PM: Andrew Prophete	tsiamis.christos@epa.gov (212) 637-4257 TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All community relations will be reported to the EM, who will coordinate with the National Grid PM and the EPA RPM.
Schedule changes	Consultant Team	TPM: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Changes to EPA-approved schedules (e.g., field sampling schedule) will be communicated to the EM, who will in turn communicate changes to the TPM for discussion with the National Grid PM and the EPA RPM.
Data release	Consultant Team	TPM: TBD QA Manager : TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All data will be reviewed by the QA Manager and TPM prior to being provided to the National Grid PM for submission to the EPA RPM.

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Notification of delays or changes to field work	Consultant Team	Field Team Leader(s): TBD TPM: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Delays or changes to the approved work plan will require approval by the EM and TPM and will be reported by the TPM to the National Grid PM who will report to the EPA RPM within 24 hours of the occurrence.
Real time changes to sample collection or analysis procedures	Consultant Team	Field Team Leader(s): TBD Lab PM: TBD TPM: TBD EM: TBD	TBD TBD TBD TBD	Conditions requiring variation to sampling and analysis procedures will be reported to the Field Team leader within 24 hours of the condition requiring the modification. The Field Team Leader will report variations to the EM and TPM as appropriate.
Reporting of issues related to data quality, including inability to meet reporting limits	Laboratory	Lab PM: TBD	TBD	Problems with data quality will be reported to the TPM and the QA Manager within 24 hours of laboratory results.

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Corrective Action	Consultant Team	QA Manager: TBD	TBD	Corrective Action Subjects: • Field Safety Audit; • Technical System Internal Audit or Field Sampling Procedure; • Offsite Laboratory Technical Systems Audit; • Offsite Laboratory Technical Systems Audit: Laboratory Personnel; • Data Quality Assessment; • Project Documentation Audit

EM = Engineering Manager
H&S = health and safety
PM = Project Manager
TPM = Team Project Manager
RPM = Remedial Project Manager
TBD = to be determined

QAPP Worksheet #7 – Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organization	Responsibilities	Educational and/or Experience Qualifications
Joel Singerman	EPA Region 2 Project Officer	EPA Region 2	Project Oversight and Management	
Christos Tsiamis	EPA Region 2 Project Manager	EPA Region 2	Project Oversight and Management	
TBD	EPA Region 2 Quality Assurance Manager	EPA Region 2	Project Quality Assurance and Quality Management	
Julianna Hess	Oversight Project Manager	CH2M Hill	Project Oversight and Management	PE
Jeff Gentry	Oversight Technical Lead	CH2M Hill	Project Technical Oversight and Management	PE
Ted Leissing	PRP Group Project Director	National Grid	Project Oversight and Management	
Andrew Prophete	PRP Group Project Manager	National Grid	Project Oversight and Management	MBA
TBD	Project Director	TBD	Final Project Oversight	TBD
TBD	Gowanus Canal Consultant Team Project Manager	TBD	Project Management	TBD
TBD	Health and Safety Manager	TBD	Health and Safety Management	TBD
TBD	Quality Assurance Manager	TBD	Quality Assurance/Quality Control	TBD
TBD	Engineering Manager	TBD	Management of Engineering Tasks	TBD
TBD	Assistant Project Manager	TBD	Project Management	TBD
TBD	Debris Reconnaissance and Removal Task Manager	TBD	Task Manager	TBD
TBD	Bulkhead Assessment Task Manager	TBD	Task Manager	TBD
TBD	Staging Site Task Manager	TBD	Task Manager	TBD
TBD	Groundwater Upwelling Investigation Task Manager	TBD	Task Manager	TBD
TBD	Evaluation of NAPL Migration Task Manager	TBD	Task Manager	TBD
TBD	Gowanus Canal Field Team Leader	TBD	Field Activity Management	TBD

TBD = to be determined

QAPP Worksheet #8 – Special Personnel Training Requirements Table

The following table is used to identify and describe any specialized and/or non-routine project specific training requirements or certifications needed by personnel to successfully complete the project or task.

Project Contributor	Specialized Training By Title or Description of Course	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Field Supervisor	8-Hour OSHA Supervisor training Project-specific SOP training	Field Team Leaders	TBD	Footnote 1
Field Team	Boater Safety Course 40-Hour OSHA HAZWOPER training	Field Personnel	TBD	Footnote 1
	Project-specific SOP training	Personnel as required		Field Office
Analytical Laboratory	NELAP Certification	Lab Personnel	TBD	Selected Laboratories

NELAP = National Environmental Laboratory Accreditation Program
OSHA HAZWOPER = Occupation Safety and Health Administration's Hazardous Waste Operations and Emergency Response[i]
SOP = standard operating procedure
TBD = to be determined

[1] Documentation for training is maintained at home office of employee and is available upon request.

QAPP Worksheet #9 – Project Scoping Session Participants Sheet

Project Name: Gowanus Canal Superfund Site **Date of Session:** 8 January 2014 **Scoping Session Purpose:** Scoping discussions for development of the PDWP and RDWP	**Site Name:** Gowanus Canal Superfund Site **Site Location:** Brooklyn, Kings County, New York

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Christos Tsiamis	Project Manager	EPA	(212) 637-4257	Tsiamis.Christos@epa.gov	Remedial Project Manager
Brian Carr	Assistant Regional Counsel	EPA	(212) 637-3170	Carr.Brian@epa.gov	EPA Counsel
Joel Singerman	Section Chief	EPA	(212) 634-4258	Singerman.Joel@epa.gov	EPA
Juliana Hess	Project Manager	CH2M Hill	(973) 316-3520	Juliana.Hess@CH2M.com	EPA Oversight Contractor – Project Manager
Jeff Gentry	Senior Technical Consultant	CH2M Hill	(503) 736-4390	Jeff.Gentry@CH2M.com	EPA Oversight Contractor – Project Manager
Ted Leissing	Manager – Site Investigation & Remediation	National Grid	(516) 545-2563	Theodore.Leissing@nationalgrid.com	National Grid Project Director
Andrew Prophete	Project Manager	National Grid	(516) 790-1654	Andrew.Prophete@nationalgrid.com	National Grid Project Manager
Allen Hecht	Sr. Counsel	National Grid	(516) 545-3795	Allen.Hecht@nationalgrid.com	National Grid Counsel
Bonnie Barnett	Partner	Drinker Biddle	(215) 988-2916	Bonnie.Barnett@dbr.com	External Counsel
Howard Cumberland	Principal	Geosyntec Consultants	(971) 271-5898	HCumberland@geosyntec.com	Geosyntec Project Manager
Jay Beech	Senior Consultant	Geosyntec Consultants	(678) 202-9506	JBeech@geosyntec.com	Geosyntec Task Manager
Richard DeWan	Senior Consultant	Geosyntec Consultants	(609) 493-9018	RDewan@geosyntec.com	Geosyntec Task Manager
Dave Himmelheber	Environmental Engineer	Geosyntec Consultants	(609) 493-9012	DHimmelheber@geosyntec.com	Geosyntec Task Manager
Roger Hathaway	Vice President	GEI Consultants	(860) 368-5316	RHathaway@geiconsultants.com	GEI Task Manager

Scoping Session Summary:

- Project Organization
    - Decision for EPA to lead the project with respect to in situ stabilization (ISS) pilot test, staging, bulkheads, pilot studies, and coordination of bridge movement with New York City (NYC).
    - National Grid (Grid) leading PRP Group efforts in the Canal.

- Submittal Process
    - Project submissions will follow the standard process. The January 10th date was extended to January 15th for Pre-Design Work Plan (PDWP) Outline.

- Bridge Clearance Issues
    - Discussion of bridge restrictions including operational heights, ability to open and close, timing and applicable city codes.
        - **Action Item**: Waiting for NYC to cooperate with bridge operation.

- Debris Removal and Management
    - Agreed on need for flexibility during this process.
        - **Action Item**: PDWP submission planned for January 28, 2014. Remedial Design Work Plan (RDWP) outline submission planned for February 6, 2014.
    - EPA and Grid noted the need for cultural resource management.

- Bulkheads
    - EPA is currently in coordination with landowners regarding upgrades to bulkheads.

- Implementation Plan and Staging Site Selection and Logistics for Project
    - Grid to manage PRP group in identifying potential properties; EPA to provide final selection and obtain property.
    - EPA to manage and lead community relations.

- Groundwater Upwelling
    - EPA noted that highest rates of groundwater upwelling in the Canal are expected in RTA 1.
    - Fulton Cutoff Wall: Discussed desire to schedule Canal remedial action to coordinate with cutoff wall installation.
        - **Action Item**: EPA to schedule more frequent meetings with NYSDEC.

- NAPL mobility: Flow Rates
    - EPA requested to initiate NAPL mobility study in RTA 1 which is expected to have the highest rates of groundwater flux.

- Pilot Studies
    - Discussed need for flexibility during pilot study process.
        - **Action item**: Future meeting to discuss in situ stabilization (ISS) Pilot at 7th Street Basin. Pilot study tentatively scheduled for Summer 2014.

- Future Workshops and meetings
    - Meeting with NYC scheduled for January 22nd. NYC has committed to considering tanks and tank siting. Noted need for coordination with NYC regarding remedial actions and tank installation.
    - Plan to discuss PDWP including Work Plan and Table 1 (items PD-3 through PD-8) on January 23rd.
    - Plan to discuss RDWP on February 12th.

QAPP Worksheet #9 – Project Scoping Session Participants Sheet (continued)

Project Name: Gowanus Canal Superfund Site **Date of Session:** 23 January 2014 **Scoping Session Purpose:** Scoping discussions for development of the PDWP and RDWP	**Site Name:** Gowanus Canal Superfund Site **Site Location:** Brooklyn, Kings County, New York

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Christos Tsiamis	Project Manager	EPA	(212) 637-4257	Tsiamis.Christos@epa.gov	Remedial Project Manager
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Joel Singerman	Section Chief	EPA	(212) 634-4258	Singerman.Joel@epa.gov	EPA
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Richard DeWan	Senior Consultant	Geosyntec Consultants	(609) 493-9018	RDewan@geosyntec.com	Geosyntec Task Manager
Dave Himmelheber	Environmental Engineer	Geosyntec Consultants	(609) 493-9012	DHimmelheber@geosyntec.com	Geosyntec Task Manager
Roger Hathaway	Vice President	GEI Consultants	(860) 368-5316	RHathaway@geiconsultants.com	GEI Task Manager

<u>Scoping Session Summary:</u>

- <u>Pre-Design Work Plan (PDWP)</u>
    - Grid provided the PDWP annotated outline to EPA on 1/15/2014.
    - Grid will provide the PDWP text to EPA on 1/28/2014 in accordance with agreed upon scope.
    - EPA will provide written comments and memo to Grid once reviewed.

- <u>Bridge Clearance Issues</u>
    - Discussion of bridge restrictions including operational heights, ability to open and close, timing and applicable city codes.
        - **Action Items**:
            - Grid will addressing these issues as they arise and develop a tracking chart to send to EPA. Chart will include a date of when Grid predicts a need for the bridges to be open to be further discussed a February 12 Workshop.

- <u>Cultural Research Management</u>
    - Site Historical Preservation Office (SHPO) historic reviews of the sonar data of sunken ships in the Canal indicate that the ships are considered potential "historic resources."
    - Former EPA archaeologist (John Vetter) is assisting EPA and attended the Community Action Group (CAG) meeting.

- <u>Insurance</u>
    - Brian Carr asked if National Grid is a self-insured company
    - Grid is self-insured, but they are exploring options and are not sure how this will play into PRPs and other Gowanus issues.

- <u>Debris Removal and Management</u>
    - Discussion on the debris impacts with an acknowledgement by all parties that there is a significant amount of debris in all RTAs and that debris is a major issue that will impact operations and schedule.
    - Agreement that debris needs to be further mapped in RTA 1 because air (oxygenation) pipe interfered with the first survey conducted.
    - Agreement that there is a need to develop a pilot study to determine removal impacts on contamination liberation, decontamination technologies, transport and disposal.
    - Debris may need to be dated for SHPO.

- <u>Bulkheads</u>
    - The goal of the Bulkhead Investigations is to complete sonar images of the bulkheads in order to increase understanding of structural foundations, the water line at the bottom of the Canal, and other relevant data.
    - NYC Bridge investigators will work with bulkhead investigators to search city historical records for information about bulkhead foundations and bridge foundations in order to gather information for necessary repairs or replacements as the process continues.
    - EPA and the PRP Group will need to coordinate with NYC for all drilling activities, including drilling around bridge foundations.

  - EPA will send Grid details on the bulkhead replacements that have already started (e.g., Lightstone).
    - Lightstone will have a sealed bulkhead. Grid will email EPA a request for bulkhead information.
    - Citizens Gate Station is considering a new bulkhead, new Federal Emergency Management Agency guidelines, etc.
      - **Action Item**: Grid to send EPA drafts of designs to know what to use, how to build, etc.
  - EPA is to work directly with property owners to determine bulkhead needs, designs, etc.
  - EPA to plan additional meeting with Grid soon to discuss bulkheads.

- <u>Implementation Plan and Staging Site Selection and Logistics for Project</u>
  - Grid to manage PRP Group in determining needs for project implementation.
  - EPA/City to help determine what property is available.
  - Need staging area in order to gain access to sites.
    - Grid to manage PRP Group in determining specific needs and then EPA will aid in gaining property access.
      - **Action Item**: Grid to propose sites to EPA for further discussion at the February 12th workshop.

- <u>Groundwater Upwelling</u>
  - Identifying upwelling areas is important for understanding fate and transport, cap design, and ISS design.
  - The groundwater study will consider various technologies for evaluating groundwater upwelling rates.
  - The study will seek to locate the most appropriate locations and technologies that work for each area.
    - This evaluation is needed to adequately address the debris and the Flushing Tunnel inhibiting factors.
    - **Action Item**: Brainstorming and planning calls to include Christos.
  - Grid to evaluate the use of the 7th Street Basin as a possible location for evaluations and pilot testing due to its lack of interference with NYC management of bridge operations and Flushing Tunnel issues.
    - Grid to evaluate seepage changes when removing soft sediments.
  - Fulton Cutoff Wall: Meeting in 2-3 weeks with EPA, DEC, and Grid.

- <u>NAPL mobility: Flow Rates</u>
  - EPA to send all Flushing Tunnel information in their possession to Grid.
    - Baird model indicates there is a significant amount of sediment movement as result of flow.
  - Agreement that not all NAPL is mobile.
  - Agreement that there is a need to conduct more studies to understand NAPL distribution and mobility within the Canal.

- <u>Implementation Schedule for ROD</u>
  - Schedule not yet proposed, Grid is producing a schedule as part of the RDWP.
    - Schedule is moving forward and progressing well as part of the RDWQ.

        - **Action Item: Per Christos:** Grid was granted an extension to complete the schedule until February 14th.
        - At this point, Christos is satisfied with how the schedule is progressing.
- <u>PDI (Pre Design Investigation) Schedule</u>
    - EPA will manage third party involvement.
    - Allows EPA to consider dividing ROD assignments to specific parties.

Worksheet #9 – Project Scoping Session Participants Sheet (continued)

Project Name: Gowanus Canal Superfund Site **Date of Session:** 12 February 2014 **Scoping Session Purpose:** Scoping discussions for development of the PDWP and RDWP	**Site Name:** Gowanus Canal Superfund Site **Site Location:** Brooklyn, Kings County, New York

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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Richard DeWan	Senior Consultant	Geosyntec Consultants	(609) 493-9018	RDewan@geosyntec.com	Geosyntec Task Manager
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Roger Hathaway	Vice President	GEI Consultants	(860) 368-5316	RHathaway@geiconsultants.com	GEI Task Manager

[1] By conference call

<u>Scoping Session Summary:</u>

- <u>EPA discussions with NYCDEP</u>
    - New York City Department of Environmental Protection (NYCDEP) and EPA had met primarily about the schedule for CSO holding tank siting and the process and tasks required to perform the tank siting. EPA received a schedule that EPA deemed to be unacceptable. EPA and NYCDEP will continue to discuss the tank siting plans.
    - Data needs and the 1st Street Turning Basin were not part of the discussions.

- <u>Bridge Clearance Issues</u>
    - EPA and NYCDOT met about the operability of the bridges over Gowanus Canal. NYCDOT stated that following Hurricane Sandy, many of the bridges are either no longer operational or have not been tested. NYCDOT is concerned with failure during operation; specifically, that the bridges will lodge in the open position. Current status is understood as follows:
        - Carroll St. is operational;
        - Union St. is operational (requires manual operation), but has not been manually opened in a number of years; and
        - 3rd St. is unoperational.
    - NYCDOT estimates that a minimum of 10 months is needed to ensure the bridge operability, with assessments being the first step. Note that the bridge at Union St. has approximately 9 feet of clearance at low tide. Grid stated that land-based access and mobilization of heavy equipment into the Canal is not expected to meet company health and safety standards and that water-based access (under the bridge) is required.

- <u>Debris Removal and Management</u>
    - Discussions regarding the removal of NYCDEP's in-Canal aeration pipe led to EPA and CH2M Hill stating that the removal plan submitted by NYCDEP to EPA did not contain details on the specifics of the removal operations. Brian Carr indicated that it is possible that concrete anchors would be left in place in the Canal and would be considered debris and would add to the debris reconnaissance and debris removal scopes of work.

- <u>Implementation Plan and Staging Site Selection and Logistics for Project</u>
    - Discussions of the location and sizing of staging sites included consideration of equipment laydown areas, access and egress points, material storage, handling and treatment areas, construction trailers, and employee parking.
    - Grid stated that they have been giving site selection considerable thought and staging site needs will be incorporated into the RDWP.

- <u>Pilot Studies</u>
    - EPA stated that they will do an ISS pilot study in the 7th Street Turning Basin.
    - EPA specified that Grid will perform any additional needed pilot studies.
    - EPA requested the information from bench-scale studies and pilot tests be made available sooner than at the 90% design level and that all of Grid's Work Plans should now reflect this schedule.

- Data Needs
    - EPA and NYCDEP discussed Flushing Tunnel operations. The Flushing Tunnel has been operating at up to approximately 70% of flow capacity. EPA will provide the daily/weekly reports on Flushing Tunnel discharges received from NYC as part of EPA's response to Grid's information request table.
    - According to EPA, EPA requested certain deliverables from NYC and NYC declined to provide them. EPA will prepare and issue a demand letter for these deliverables.
    - Treatability and field pilot studies that are needed during the PDWP to advance the remedial design were discussed.
        - Grid consistently and clearly stated that many of the pre-design pilot studies are needed to further develop the remedial design. Needed pilot studies include groundwater flux and modeling, capping, ISS, debris removal, dredging, dredged material treatment, and water treatment.

- Sequencing
    - Grid led a discussion with EPA to determine general concurrence on the sequencing of Remedial Design and Implementation activities by remediation target area (RTA) and a discussion on the design need similarities and differences. The discussion included:
        - Design needs:
            - RTA 1:
                - ISS, other capping alternatives, groundwater, Flushing Tunnel, bulkheads, pre-design investigations,
                - Treatability and Pilot studies,
                - Source Controls - CSOs, Storm Sewers, unpermitted discharges, etc.
            - RTA 2:
                - ISS, other capping alternatives, groundwater, Flushing Tunnel, bulkheads, pre-design investigations, more debris, turning basins and Navigation issues,
                - Treatability and Pilot studies,
                - Source Controls – CSOs, Storm Sewers, unpermitted discharges, etc.
            - RTA 3:
                - Different (better) logistics, simpler, faster dredging production rates, no amendments in cap (clean cover) little to no groundwater issues, functioning navigation channel.
        - Construction needs in RTAs:
            - Access, logistics, site staging, clearance.
        - The Need to model effect of sequencing on sediment transport and hydrodynamics.

- EPA Comments on Submittals
    - PDWP:
        - EPA will provide written comments on PDWP and a memo to Grid.
        - EPA requested that the following pre-design efforts be performed in the summer of 2014:
            - ISS Pilot Study
            - Groundwater flux study.

            - Locations were discussed which could be accessed without the need for bridge operation, and there was general consensus that studies would need to be conducted where bridge operability is not a concern.
    - RDWP:
        - RDWP Outline was submitted on 2/6/14, no significant comments were discussed by EPA.
        - CH2M Hill and EPA requested a flow diagram to show how the remedial design will be implemented. Grid/Geosyntec responded that is in development and will be included.

- <u>Proposed NYC Sediment Removal Action</u>
    - Geosyntec inquired of EPA if they had any discussions with NYC during their meeting on a proposed removal action by the City that is the subject of the Public Notice (# NAN-2012-01342-EHA) issued by the New York District (NYD) of the US Army Corps of Engineers (USACE.) on January 28,2014.
        - EPA is aware of the proposed action. EPA did not provide details about their specific plans to address this proposed sediment removal action except to say that they will act to make sure the proposed removal action does not happen.
        - EPA did encourage Grid to submit comments under the public notice.
        - EPA implied that they have a copy of the public notice but do not have a copy of the full application. However, there still seemed to be some uncertainty on what exactly EPA has and doesn't have with regards to NYC's proposed sediment removal action in RTA 1. Grid will add this request to the Request Table.

- <u>Future Workshops and meetings</u>
    - Discussions with NYC Department of Transportation (DOT) regarding the 1st Street Turning Basin are needed.
    - EPA and Grid discussed the need for pre-design task workshops including: groundwater flux modeling, Flushing Tunnel impacts, hydrodynamic model outputs, and staging/access areas, locations, and logistics.

QAPP Worksheet #10 – Conceptual Site Model

The problem definitions are provided in the following worksheets:

QAPP Worksheet #10a – PD-3: Additional Debris Reconnaissance

QAPP Worksheet #10b – PD-4: Development of Debris Removal and Management Plan

QAPP Worksheet #10c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

QAPP Worksheet #10d – PD-6: Staging Site Selection and Implementation Plan

QAPP Worksheet #10e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

QAPP Worksheet #10f – PD-8: Evaluation of NAPL Mobility in Native Sediments

QAPP Worksheet #10a – PD-3: Additional Debris Reconnaissance

Background Information:

This work element has been developed to perform additional debris reconnaissance in the Canal to identify and characterize Site conditions, anomalies, obstructions, and potential submerged cultural resources in areas where debris identification was not performed in the December 2010 study or where survey results require confirmation. Note that debris will consist of non-sediment material.

Sources of Known or Suspected Hazardous Wastes:

Debris in the Canal may have originated in upland areas or may have been deposited in the Canal from vessels on the waterway. Debris consists of a variety of materials, some of which may be hazardous, such as discarded containers of household hazardous waste.

Debris may also be saturated with surface water or be heavily coated in sediment which contains contaminants.

Known or Suspected Contaminants or Classes of Contaminants:

Debris may be coated with sediments contaminated with target compound list (TCL) volatile organic compounds (VOCs), TCL semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and target analyte list (TAL) metals. Debris may be saturated with surface water contaminated with TCL VOCs, TCL SVOCs, TAL metals, and bacteria.[1]

Primary Release Mechanism:

Debris in the Canal may have originated in upland areas and traveled to the Canal via many mechanisms which include erosion, dumping, and transport through the combined sewer overflows (CSOs). Additional debris may have been accidentally released or dumped off of waterway vessels.

Secondary Contaminant Migration:

As debris is removed, sediment may be disturbed and suspend in the water column. Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption.

Land Use Considerations:

Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future.

The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.

Key Physical Aspects of Site:

There were areas of the Canal which were unable to be evaluated during the high-frequency side-scan sonar study conducted in December 2010 due to interferences, however these areas need to be scanned as part of this reconnaissance effort. Previous interferences will be addressed by the following measures:

- The oxygen transfer system will be removed prior to the additional reconnaissance activities;
- The activities will be coordinated to occur when the mouth of the Canal is free of construction and work barges;
- Alternatives to side-scan sonar may be used, such as a tripod-mounted, high-resolution, 360-degree scanning sonar which can be deployed adjacent to hard-to-reach areas to generate plan-view sonar imagery; and,
- Physical verification of significant debris fields identified during this survey and previous surveys.

Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making:

Debris could be present throughout the length of the Canal. Locations determined to contain debris during the 2010 study will be confirmed during this task.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10b – PD-4: Development of Debris Removal and Management Plan

Background Information:

This work element has been prepared to properly and lawfully plan and manage the identification, removal, testing and disposal of all non-sediment materials present in the Canal. The overall objective of this work element is to develop a plan (Debris Plan) to govern the removal and/or management of identified debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated.

Sources of Known or Suspected Hazardous Wastes:

Debris in the Canal may have originated in upland areas or may have been deposited in the Canal from vessels on the waterway. Debris consists of a variety of materials, some of which may be hazardous, such as discarded containers of household hazardous waste.

Debris may also be saturated with surface water or be heavily coated in sediment which contains contaminants.

Known or Suspected Contaminants or Classes of Contaminants:

Debris may be coated with sediments contaminated with TCL VOCs, TCL SVOCs, PCBs, and TAL metals. Debris may be saturated with surface water contaminated with TCL VOCs, TCL SVOCs, TAL metals, and bacteria.[1]

Primary Release Mechanism:

Debris in the Canal may have originated in upland areas and traveled to the Canal via many mechanisms which include erosion, dumping, and transport through the CSOs. Additional debris may have been accidentally released or dumped off of waterway vessels.

Secondary Contaminant Migration:

As debris is removed, sediment may be disturbed and suspend in the water column. Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption of other contaminated species in the food chain.

Land Use Considerations: Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future. The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.
Key Physical Aspects of Site: Due to a general lack of available real estate on or close to the Canal, as well as intent to minimize impact of remedial operations on residential neighborhoods, it is anticipated that debris removal and management activities will be performed in or upon the water. Notwithstanding the completion of PD-6 to identify potential staging sites, it is not anticipated that a shoreline staging area will be available, so removed debris will be placed onto a transfer barge. The barge or series of barges will serve as a management staging area, where debris will be sorted based on material composition.
Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making: Debris location information gathered during PD-3 will inform the conceptual site model (CSM) for PD-4 implementation prior to field activities and debris removal.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

Background Information:

The overall objectives of the bulkhead survey and assessment work element are to provide a plan for performing a preliminary assessment of the stability of existing bulkheads during and after remedy implementation, and to create a preliminary design of temporary and permanent bulkhead support systems. There is limited available information on the construction practices, as-built conditions, and design of the existing bulkheads. Furthermore, there is limited available geotechnical design data for the Canal. The bulkhead survey, which includes a Bulkhead Investigation and Geotechnical Site Investigation, is required to address the data gaps.

Results from the bulkhead survey and assessment will be used to refine the comprehensive CSM (PD-25) and will directly support the remedial design and remedial activities.

Sources of Known or Suspected Hazardous Wastes:

Sediments are known to be contaminated with TCL VOCs, TCL SVOCs, PCBs, and TAL metals. Surface water is known to be contaminated with TCL VOCs, TCL SVOCs, TAL metals, and bacteria.[1]

Known or Suspected Contaminants or Classes of Contaminants:

Drilling activities may disturb sediment and cause sediment suspention in the water column. Contaminants may migrate via water currents or may be consumed by biota present in the Canal.

Primary Release Mechanism:

Contaminants in the sediment may have originated in upland areas and traveled to the Canal via many mechanisms which include erosion, dumping, and transport through CSOs. Additional contaminants may have been accidentally released or dumped off of waterway vessels.

Secondary Contaminant Migration:

As debris is removed, sediment may be disturbed and suspended in the water column. Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption of other contaminated species in the food chain.

Land Use Considerations:

Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future.

The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.

Several properties towards the mouth of the Canal will continue to be industrial.

Key Physical Aspects of Site:

Bulkheads exist along both sides of the Canal. There are no available documents or construction as-builts that provide the bottom of the foundations of the existing bulkheads. Bulkheads have been assessed based on assumed foundation depths inferred from assumed construction practices as follows:

- Crib bulkheads are built on top of native soil (elevation determined from nearby cone penetrometer tests (CPTs) and borings);
- Steel and timber piles are driven approximately 5 feet (ft) into medium dense to dense glacial till deposits with a maximum pile length of 50 ft. (elevation determined from nearby CPTs and borings); and
- Embankments are built directly on sediments.

Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making:

All of the bulkheads will be investigated and analyzed for stability.

QAPP Worksheet #10d – PD-6: Staging Site Selection and Implementation Plan

Background Information:

The remedial actions listed in the Record of Decision will require the mobilization of manpower, machinery, and supplies to the area. Staging areas will be required to facilitate the movement of labor, equipment, and material between upland areas to and from the Canal. This work element has been developed to provide a framework for the preparation of a Site Staging and Implementation Plan to govern infrastructure, construction, and site staging operations at the Site.

To meet the stated objective of this work element, a plan will be developed to include, but not be limited to:

- Evaluation of Construction Phasing and Sequencing;
- Analysis of Labor, Equipment, and Materials Needs;
- Identification of Staging Site Requirements;
- Staging Site Identification;
- Staging Site Evaluation; and
- Implementation of Staging Site Activities.

Sources of Known or Suspected Hazardous Wastes:

Soils, groundwater and sediments of the Canal have been impacted by commercial and industrial activities along the Canal since industrialization of the area began.

Known or Suspected Contaminants or Classes of Contaminants:

While specific sites have not selected or evaluated yet, groundwater in the area is impacted by non-aqueous phase liquids (NAPL) and has also demonstrated impacts of VOCs, SVOCs, and metals. Previous industrial activities may have affected individual properties in the area with the same contaminants.[1]

Primary Release Mechanism:

Since properties have not been evaluated, the mechanism for any given property is unknown. However, spills and discharges from past industrial practices are known to have occurred in the area.

Secondary Contaminant Migration:

Unknown.

Fate and Transport Considerations: If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.
Potential Receptors and Exposure Pathways: Humans may be exposed to contaminants though contact with surface water, soils, or sediment during Site evaluation and development activities.
Land Use Considerations: Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future. The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.
Key Physical Aspects of Site: Staging site selection will seek to identify one or more properties adjacent to the Canal which can be used. Due to limited availability of real estate close to the Canal and a desire to minimize impact of remedial operations on residential neighborhoods, it may be necessary to conduct some activities on barges located in the Canal. However, staging areas will be necessary to transfer labor and equipment from the land to marine equipment. Administrative areas for construction will be needed along with stockpile areas for materials, parking areas for vehicles, and docking for workboats. Properties with both land and marine transportation access are desired. The high degree of urbanization will affect the ability to find suitable properties.
Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making: The nature and extent of potential contamination will be evaluated during the site selection process. Sites could be eliminated from consideration based upon the nature and extent of contamination.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

Background Information:

This work element has been developed to investigate the occurrence of groundwater upwelling within the Gowanus Canal and measure representative groundwater discharge rates associated with upwelling areas. The groundwater upwelling work element builds upon information contained in the Remedial Investigation/Feasibility Study (RI/FS) reports for the Site and refines and improves the Site-wide comprehensive CSM to support remedial design activities.

In order to better characterize groundwater discharge rates into the Canal, and the impact on remedial design for *in situ* stabilization (ISS), capping, and bulkheads, field data are needed to identify groundwater upwelling areas and discharge rates.

To meet the primary objectives of this work element, the following sub-tasks will be performed:

- Evaluate and select applicable technologies for locating groundwater discharge areas and quantifying discharge rates;
- Evaluate and select areas of the Canal for groundwater upwelling measurements;
- Inspect Site to confirm feasibility of selected technologies at target locations;
- Implement selected technologies to assess groundwater upwelling areas and discharge rates;
- Characterize the hydraulic conductivity between the native and soft sediments;
- Refine the groundwater CSM and groundwater model; and
- Data management, analysis, and reporting.

Sources of Known or Suspected Hazardous Wastes:

Groundwater has been impacted by commercial and industrial activities along the Canal since industrialization of the area began. [1]

Known or Suspected Contaminants or Classes of Contaminants:

Groundwater is impacted by NAPL and has also demonstrated impacts of VOCs, SVOCs, and metals.

Primary Release Mechanism:

Contaminant sources to groundwater were identified from previous releases and industrial activity during the RI Site work.

Secondary Contaminant Migration:

The RI/FS notes the following three mechanisms that control NAPL migration into the Canal:

- Upward seepage via vertically upward hydraulic gradients associated with groundwater advection.
- Lateral seepage via spreading along the saturated/unsaturated zone interface.
- Upward transport via ebullition due to biodegradation of organic matter or other processes (CH2M Hill, 2013).
- NAPL and other contaminants in groundwater have the potential to migrate out of the Canal after they are released through upwelling.
- Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption of other contaminated species in the food chain.

Land Use Considerations:

Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future.

The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.

Key Physical Aspects of Site:

Side-scan and magnetometer data, collected in collaboration with PD-3, will be used identify the presence and density of bottom debris. This will help identify areas of the Canal where physical obstacles would hinder the implementation of one or more of the identified technologies and the need to eliminate the area from testing or to focus debris removal. Locations with relatively little accumulation of soft sediment will also be identified as areas with enhanced potential for preferential flow-paths and increased groundwater upwelling.

Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making:

A detailed evaluation will be conducted to assess the distribution of NAPL within Canal sediments. Results of this evaluation will aid in determining where in the Canal groundwater upwelling will be assessed. Measurements will be more densely focused in areas of greater anticipated NAPL distribution.

QAPP Worksheet #10 – Conceptual Site Model (continued)

Specific sampling locations and number of samples have not yet been identified.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10f – PD-8: Evaluation of NAPL Mobility in Native Sediments

Background Information:

This work element has been developed to improve understanding regarding the potential for upward NAPL mobility in native sediments within the Canal. The NAPL mobility work element builds upon information contained in the Site RI/FS reports and refines and improves the Site-wide comprehensive CSM to direct remedial design activities, specifically ISS and capping.

Sources of Known or Suspected Hazardous Wastes:

Groundwater and sediments of the Canal have been impacted by commercial and industrial activities along the Canal since industrialization of the area began.

Known or Suspected Contaminants or Classes of Contaminants:

Groundwater and sediments are both known to be impacted by NAPL, TCL VOCs, TCL SVOCs, and TAL metals. Sediments also have demonstrated PCB impacts. For the purposes of this work element, TCL VOCs, TCL SVOCs, and TAL metals in NAPL and groundwater are the focus of study.

Primary Release Mechanism:

The NAPL has at least two suspected origins:

- Through the subsurface from the upland Sites; and/or
- From overland discharge into the Canal.

Secondary Contaminant Migration:

NAPL and its associated contaminants may migrate under the following pathways:

- NAPL migration from deep sediments to shallower sediments near the surface, through the following mechanisms:
  - Upward seepage via vertically upward hydraulic gradients associated with groundwater advection;
  - Lateral seepage via spreading along the saturated/unsaturated zone interface; or
  - Upward transport via ebullition due to biodegradation of organic matter or other processes (CH2M Hill, 2013)
- Dissolved-phase solute migration in groundwater after dissolution from NAPL.
- Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.
Potential Receptors and Exposure Pathways: Humans and biota may be exposed to contaminants through contact with surface water or sediment or through consumption of other contaminated species in the food chain.
Land Use Considerations: Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High-density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future. The Canal is regularly used by commercial barges at several facilities along the mid- and lower sections of the Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.
Key Physical Aspects of Site: Sampling activities associated with this task will take place on the water and will have to go through the water column. Samples collected of native sediment will also have to pass through the full column of soft overlying sediments.
Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making: For the purposes of the PDWP, the process of upward vertical transport of NAPL within the Canal footprint is the area of focus; potential lateral transport of NAPL into the Canal via bulkheads is addressed separately through upland remedial activities and possibly additional pre-design investigations. Field and laboratory work completed by EPA as part of the RI/FS provides an initial understanding of NAPL distribution and potential for upward mobility; however, in order to optimize the design of ISS and capping remedial measures, further refinement of the NAPL CSM is required to understand the mechanisms of NAPL mobility in the Canal. The primary CSM data needs related to upward NAPL mobility are as follows: • The origin of the NAPL within the Canal area; and • The conditions under which NAPL can become upwardly mobile. Specific sampling locations and number of samples have not yet been identified.

CPT = cone penetrometer test
CSM = conceptual site model
CSO = combined sewer overflow
ISS = *in situ* stabilization
ft = feet
NAPL = non-aqueous phase liquid

PCBs = polychlorinated biphenyls
RI/FS = Remedial Investigation/Feasibility Study
SVOCs = semi-volatile organic compound
TAL = Target Analyte List
TCL = Target Compound List
VOC = volatile organic compound

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements

The following worksheets describe the project data quality objectives (DQOs). Note that specific analytical methods for samples are provided in WS#18 – Sampling Locations and Methods/SOP Requirements Table.

The project DQOs and data needs are presented in the 7-step DQO process provided in the following worksheets.

QAPP Worksheet #11a – PD-3: Additional Debris Reconnaissance

QAPP Worksheet #11b – PD-4: Development of Debris Removal and Management Plan

QAPP Worksheet #11c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

QAPP Worksheet #11d – PD-6: Staging Site Selection and Implementation Plan

QAPP Worksheet #11e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

QAPP Worksheet #11f – PD-8: Evaluation of NAPL Mobility in Native Sediments

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11a – PD-3: Additional Debris Reconnaissance

STEP 1: State the Problem

Debris exists in the Canal which may interfere with remedy implementation. Some areas of the Canal have already been investigated for debris, but other areas of the Canal have not yet been scanned.

STEP 2: Identify the Goals of the Study

This work element has been developed to perform additional debris reconnaissance for debris removal in the Canal in areas not previously surveyed or where survey results require confirmation.

STEP 3: Identify the Information Inputs

1. A high-frequency side-scan sonar study of the Canal was conducted in December 2010. Information gathered during that event will be confirmed during this event.
2. High-frequency side-scan sonar to confirm findings of the 2010 study and investigate new areas not covered in the 2010 study.

STEP 4: Define the Study Boundaries

The study boundary is the surface of the sediment located within the full length of the Canal. The Record of Decision (ROD) further divides the Canal into 3 Remediation Target Areas (RTAs) known as RTA-1, RTA-2, and RTA-3. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- If debris is encountered, then it will be characterized and added to the scope of the Plan for Debris Removal, Decontamination, and Disposal (PD-4). To the extent practical, the debris will be quantified by volume per designated area and categorized into 1 of 4 main types of debris: metal, concrete, tires, or wood.

STEP 6: Specify Performance Criteria

The sonar scan must meet the professional standard of performance and be performed by trained subcontractors. When debris is encountered, it will be evaluated and scheduled for removal per PD-4 - Development of Debris Removal and Management Plan.

STEP 7: Optimize the Design for Obtaining Data

Significant debris identified prior to this survey will be verified.

The interferences that previously prevented the completion of the high-frequency side-scan sonar activities in these areas will be addressed by the following measures:

- The oxygen transfer system will be removed prior to the additional reconnaissance activities;
- The activities will be coordinated to occur when the mouth of the Canal is free of construction and work barges;
- Alternatives to side-scan sonar may be used, such as a tripod-mounted, high-resolution, 360-degree scanning sonar which can be deployed adjacent to hard-to-reach areas to generate plan-view sonar imagery; and,

• Significant debris fields identified during this survey and previous surveys will be verified. The debris reconnaissance will be optimized as appropriate during field implementation.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11b – PD-4: Development of Debris Removal and Management Plan

STEP 1: State the Problem

Debris in the Canal needs to be removed and/or otherwise managed such that it does not interfere with the remedy.

STEP 2: Identify the Goals of the Study

This work element has been prepared to plan and manage the identification, removal, testing and disposal of all non-sediment materials present in the Canal. The overall objective of this work element is to develop a plan (Debris Plan) to govern the removal and/or management of debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated. Elements of the Debris Plan will include debris removal, debris decontamination, debris handling and disposal, and cultural resources management.

STEP 3: Identify the Information Inputs

1. Information gathered regarding the location of debris in PD-3will be used to develop the Debris Removal and Management Plan.
2. Information gathered in the 2010 high frequency side-scan sonar will also be used.

STEP 4: Define the Study Boundaries

The study boundary is the surface of the sediment located within the full length of the Canal. The ROD further divides the Canal into 3 RTAs known as RTA-1, RTA-2, and RTA-3. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- A technical scope will be developed for removing debris located within the Canal such that media disturbance is minimized during debris removal.
- An environmental monitoring plan will be developed for implementation during debris removal. Corrective measures will be proposed to mitigate possible disturbances.

STEP 6: Specify Performance Criteria

The debris management plan must meet the professional standard of performance and be performed by individuals with appropriate training and credentials.

STEP 7: Optimize the Design for Obtaining Data

Not applicable.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

STEP 1: State the Problem

Existing bulkheads along the Canal will be impacted during the remedy implementation. A survey is needed to determine which bulkheads require reinforcement or replacement to avoid failure during dredging operations.

STEP 2: Identify the Goals of the Study

This work element has been developed to survey and assess bulkhead conditions along the Canal for the purpose of evaluating their anticipated integrity during remedial implementation. As part of this task, a bulkhead and Geotechnical Site Investigation will be performed. Data collected from the Investigation will be used to evaluate the bulkheads' temporary stability during remedial implementation and long-term stability for the post remedial condition. For bulkheads which do not meet the minimum credible structural standards for either temporary or long-term conditions, temporary support or permanent reinforcements or replacements will be designed.

STEP 3: Identify the Information Inputs

1. Previous research:
    a. Information contained in the Remedial Design/Feasibility Study reports for the Site
    b. Brown, A., "Gowanus Canal, Bulkhead Inventory Survey," July 2000.
    c. GEI Consultants, Inc., "Draft Bulkhead Summary, Gowanus Canal Superfund Site, Brooklyn, New York," March 8, 2012.
    d. GEI Consultants, Inc., Gowanus Canal–Web GIS Interface, 2013.
    e. Ocean Surveys, Inc., Multibeam Hydrographic Survey, August 2013.
    f. United States Environmental Protection Agency, "Record of Decision, Gowanus Canal Superfund Site, Brooklyn, King County, New York," September 2013.
2. Review of any available as-builts of existing bulkheads.
3. Subsurface Investigation of Existing Bulkhead Foundations to be completed as part of this task.
4. Geotechnical Site Investigation to be completed as part of this task (WS#18 provides a list of the analytical methods).

STEP 4: Define the Study Boundaries

All bulkheads along the length of the Canal. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- If bulkheads along the Canal do not meet minimum credible structural standards to implement the remedy, then temporary or permanent reinforcements or replacements will be designed.
- If bulkheads along the Canal do not meet minimum credible structural standards for the post remedy condition, then permanent reinforcements or replacements will be designed.

STEP 6: Specify Performance Criteria

Analytical samples must meet the applicable quality control acceptance criteria, meet the professional standard of performance, and be analyzed by accredited institutions or professions as applicable.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

STEP 7: Optimize the Design for Obtaining Data It is possible that multiple testing methodologies will be selected to accomplish the goals of this task. Technologies and sampling locations may be adjusted based on field conditions.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11d – PD-6: Staging Site Selection and Implementation Plan

STEP 1: State the Problem

A staging site is needed to meet construction needs in order to assemble and transfer labor, equipment, supplies, and material during remedial activities.

STEP 2: Identify the Goals of the Study

The objective of this work element is to develop a plan describing the means to:

- Identify project infrastructure needs;
- Determine necessary staging site requirements;
- Identify potential staging sites; and
- Evaluate staging sites.

STEP 3: Identify the Information Inputs

1. Evaluation of Construction Phasing and Sequencing;
2. Analysis of Labor, Equipment, and Materials Needs;
3. Identification of Staging Site Requirements;
4. Staging Site Identification; and
5. Staging Site Evaluation

STEP 4: Define the Study Boundaries

Staging site selection will be considered in areas on, near to, or adjacent to the Canal and will incorporate consideration for work for each of the RTAs. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- If sites are evaluated which meet the acceptance criteria for site selection, then EPA will make the final decision regarding which site to use and will aid in acquiring site access.
- If potential staging sites identified are inappropriate based on site visits, additional sites will be considered.
- If sites with unacceptable characteristics cannot be acceptably mitigated, then they will be removed from further consideration.

STEP 6: Specify Performance Criteria

Site selection should be able to accommodate requirements determined during the selection process. If site visits indicate site is inadequate to meet project needs and the issues cannot be rectified, sites will be removed from consideration.

STEP 7: Optimize the Design for Obtaining Data

- A desktop study will be conducted first using interviews, available zoning information, and aerial mapping tools prior to site visits. Following site visits, if investigated sites are not appropriate, further desktop review will be conducted prior to the next site visit.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

STEP 1: State the Problem

Groundwater upwelling is a potential source of contaminant migration, and it will affect the installed remedy. Understanding areas of upwelling and quantifying discharges rates are required to appropriately design a permanent remedy.

STEP 2: Identify the Goals of the Study

Two primary objectives of this work element are to determine the approximate areas of significant groundwater upwelling in the Canal and, for those areas where upwelling is identified, to estimate the rate and velocity of this discharge.

STEP 3: Identify the Information Inputs

1. Evaluate and select applicable technologies for locating groundwater upwelling areas and quantifying discharge rates;
2. Evaluate and select areas of Gowanus Canal for groundwater upwelling measurements;
3. Inspect locations within the Canal to confirm feasibility of selected technologies at target locations;
4. Implement selected technologies to assess groundwater upwelling areas and discharge rates;
5. Characterize the hydraulic conductivity between the native and soft sediments;
6. Refine the groundwater conceptual site model (CSM) and groundwater model; and
7. Data management, analysis, and reporting.

STEP 4: Define the Study Boundaries

The entire length of the Canal will be considered in the study. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

Analytical approaches are included for the initial screening of technologies, the evaluation of locations to implement the technologies, and the selection of technologies following evaluation of locations.

1. Numerous technologies will be evaluated through an initial screening process for their potential to identify groundwater upwelling areas and where identified, quantify groundwater discharge rates. If a technology appears to be appropriate and feasible based on the current CSM, then that technology will be retained for further consideration.
2. Locations within the Canal will be evaluated by considering previously acquired side-scan survey data conducted as part of the Remedial Investigation. A secondary step of performing current site surveys to confirm historical or determine current conditions, if changed, will be implemented. If these locations are considered feasible for the implementation of the retained technologies based on surface access and bottom debris, then those locations will be retained for further investigation.
3. Areas deemed feasible based on steps 1 and 2 will be evaluated to select the appropriate technology for evaluation of upwelling and groundwater discharge.
4. In locations where groundwater discharge is quantified, additional investigation will characterize the hydraulic conductivity between the native and soft sediments.
5. If the groundwater upwelling areas and measured discharge rates are significantly different than anticipated based on results from the 2011 flow model, or if the contrast in hydraulic conductivities between the native and soft sediments are significantly different than the current hydraulic conductivity value used for the sediment in the 2011 flow model, then the flow model will be further refined and re-calibrated.

STEP 6: Specify Performance Criteria

Both non-aqueous phase liquid (NAPL) impacted and non-NAPL impacted areas that are considered feasible for evaluation based on surface and bottom conditions will undergo field characterization to confirm feasibility with the applicable technologies.

During this implementation phase, multiple technologies will likely be used to provide independent and complementary lines of evidence that characterize the nature and extent of groundwater upwelling into the Canal. The utility of an initial, demonstration-scale implementation step will be considered to obtain Site-specific data in advance of a full-scale implementation for technologies warranting methods demonstration. This will be true for both for evaluating upwelling areas and quantifying discharge rates. The performance criteria for evaluating upwelling will be to confirm the upwelling with a quantifiable groundwater discharge rate. If it is determined that upwelling is occurring in a specified area, but no discharge able to be measured, an additional technology to quantify discharge will be attempted. If no discharge is measured with the second technology then further evaluation of the groundwater upwelling results will be considered.

All data will be collected by knowledgeable, experienced staff for the particular technology implemented.

STEP 7: Optimize the Design for Obtaining Data

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work as it is implemented. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA.

QAPP Worksheet #11f – PD-8: Evaluation of NAPL Mobility in Native Sediments

STEP 1: State the Problem

NAPL mobility in the Canal could reduce the effectiveness of the remedy after installation. The distribution of NAPL within the Canal and the potential for NAPL mobility must be understood to account for potential NAPL loading due to mobilization in the in situ stabilization (ISS) and/or capping remedial design.

STEP 2: Identify the Goals of the Study

The primary objectives of this work element are to (i) quantify the NAPL distribution within the Canal, (ii) define areas of potentially mobile NAPL, and (iii) quantify and characterize the controlling factors of NAPL mobility.

STEP 3: Identify the Information Inputs

1. Desktop evaluation of NAPL mobility and selection of appropriate field-screening technology(ies) and assessment locations.
2. Implementation of field-based approaches to assess in situ NAPL distribution.
3. Laboratory groundwater and NAPL characterization and mobility testing. Analytical testing includes TCL VOCs, TCL SVOCs, and TAL metals.

STEP 4: Define the Study Boundaries

The results of the desktop evaluation will select one or more focus areas within the Canal for assessment of the field-screening technology(ies). If the results of the focus area(s) are positive, than a larger area that will not be larger than the length of the Canal may be investigated. While the program may be phased and dynamic in nature to allow for refinement, overall is planned to be a one-time investigative program. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

The desktop evaluation will provide the information needed to select the field-screening technology(ies) and assessment area(s) and locations to assess the NAPL distribution and potential NAPL mobility. If the desktop study shows that the planned methods (e.g., TarGOST, cone penetrometer testing, acetate core liners, etc.) are generally effective in settings similar to the Canal, then they will be used in the performance of the PD-8 work element.

The in situ NAPL distribution will be assessed using the field-based screening approaches. If the distribution of NAPL differs from what is currently understood, then the remedial design will be modified to reflect the refined footprint of NAPL contamination.

Based upon the field-screening technology(ies) results, collocated undisturbed sediment cores will be collected from a sub-set of the assessment locations for confirmatory laboratory analysis. These undisturbed cores will be analyzed by methods to understand and confirm the field-screening technology(ies) for NAPL saturation, soil physical parameters (i.e., geotechnical), and other parameters to help understand NAPL distribution (i.e., saturation). If significant differences in the findings between the field screening measures and laboratory-based measures of NAPL saturation are observed, the two different datasets will be critically reviewed to select the most accurate depiction of NAPL presence for the purposes of the remedial design.

A laboratory mobility testing method that mimics natural conditions will be used to assess the mobility of the NAPL within the sediments. The goal of the laboratory-scale work is to understand, among other factors, the vertical seepage velocity and hydraulic head gradients that are necessary to cause upward migration of the NAPL within the native sediments. If upward migration of the NAPL within the native sediments occurs during testing, then the remedial design will be focused in these areas to provide appropriate measures of NAPL interception.

STEP 6: Specify Performance Criteria

Inaccurate conclusions regarding similarities or differences between analytical sample values or field measurements are possible due to dataset variability (i.e., Types I/Type II error.) This will be managed by assessing variability in each dataset with respect to the magnitude of differences between readings to evaluate the extent to which conclusive decisions can be made about the (dis)similarity in the datasets.

Samples collected as part of this task must meet the applicable quality control acceptance criteria, meet the professional standard of performance, and be analyzed by accredited institutions or professions as applicable.

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work as it is implemented. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA.

STEP 7: Optimize the Design for Obtaining Data

It is possible that multiple technologies will be selected to provide independent and complementary lines of evidence that characterize NAPL mobility in native sediments. These technologies will be selected based on the results desktop study.

CSM = conceptual site model
NAPL = non-aqueous phase liquid

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

RTA = remediation target area
ROD = Record of Decision
SVOC = semi-volatile organic compounds
TAL = Target Analyte List
TCL = Target Compound List
VOC = volatile organic compound

QAPP Worksheet #12 – Measurement Performance Criteria Table

Measurement Performance Criteria listed below applies only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Laboratory:	To be determined (TBD)
Matrix:	Water
Analytical Group:	**TCL VOCs**
Sampling Procedure:	TBD
Analytical Method/SOP Reference:	SW846 8260B/ See Worksheet 23
Concentration Level:	Low

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per NELAP Certification requirements	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Tune standard BFB (4-Bromofluorobenzene)	Each 12-hour time period. The 12-hour time period begins at the moment of injection of BFB.	Sensitivity	Must meet the abundance criteria listed in per Laboratory standard operating procedure (SOP) when selected	A
Initial Calibration	Prior to sample analysis	Accuracy	The % RSD of the calibration check compounds (CCC) must be less than 30%. If none of the CCCs are required analytes, project specific calibration specifications must be agreed with the client. The 5 system performance check compounds (SPCC) are checked for a minimum average response factor (RF). Where a target compound is ≤15% RSD average RF may be used. If the 15% RSD criteria are exceeded, the linear curve, quadratic curve or polynomial curve must have a correlation coefficient of ≥ 0.995. Compound list will be divided into 2 lists: List 1 (reliable performers) and List 2 (poor performers). List 1 compounds should always have a %RSD less than 30% or correlation coefficient of 0.995 with an allowance of up to 2 sporadic marginal failures. Sporadic marginal failures for these compounds should be ≤ 40% or 0.990. For List 2 analytes, where the %RSD is ≤15% an average response factor will be used. For %RSDs >15% and ≤60% the best fit curve will be selected.	A
Initial calibration verification	Analyzed with each initial calibration.	Accuracy	The acceptance criteria are 75-125% for most compounds and 50-150% for poor method performers. The poor performers are footnoted in SOP Tables 3 and 4. Any compound not listed will fall into the 50-150% criteria until knowledge of the compound can be developed.	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory:	To be determined (TBD)
Matrix:	Water
Analytical Group:	**TCL VOCs**
Sampling Procedure:	TBD
Analytical Method/SOP Reference:	SW846 8260B/ See Worksheet 23
Concentration Level:	Low

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Continuing calibration verification	Must be analyzed every twelve hours		CCCs must be ≤20 %diff. List 1 compounds that are non-CCCs must be ≤25 %diff or drift. Up to 2 compounds that are List 1 analytes may exceed the 25% criteria, but must be ≤40%. List 2 analytes including Appendix IX compounds must have % diff or % drift ≤50%.	A
Method blank	With each batch of samples. The method blank is analyzed after the calibration standards, normally before any samples.	Sensitivity	The method blank must not contain any analyte of interest ≥ PQL (except common laboratory contaminants, methylene chloride, acetone, 2-butanone) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher. Common laboratory contaminants < 5 times the PQL.	A
Laboratory Control Sample (LCS)	With each batch of samples. The LCS is analyzed after the calibration standard, and normally before any samples.	Accuracy	Control analytes and surrogates must be within historical control limits.	A
Matrix spike/matrix spike duplicate (MS/MSD)	With each QC batch	Accuracy & Precision	Percent recovery & Relative Percent Difference (RPD) within laboratory historical control limits.	S & A
Performance Testing Sample	Prior to each phase of the study	Accuracy	Results must be within vendor specified acceptance criteria	A
Trip Blank	1 per cooler containing aqueous VOC samples; not required for sediment	Sensitivity	No analytes > PQL	S
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per lot of source water	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TCL SVOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8270C/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per specification of NELAC	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Tune standard Deca-fluorotriphenylphosphine (DFTPP)	At the beginning of every twelve hour shift, including calibration and when analyses are to be performed	Sensitivity	Per the specifications of the laboratory SOP once selected	A
Initial Calibration	Prior to sample analysis	Accuracy	System Performance Check Compounds (SPCCs): The minimum average RF for SPCCs is 0.050. Calibration Check Compounds (CCCs): The %RSD of the RFs for each CCC in the initial calibration must be less than 30%. If none of the CCCs are required analytes, project specific calibration specifications must be agreed with the client. Where a target compound is ≤15% RSD, an average RF may be used. If the 15% RSD criteria is exceeded for a non-CCC target compound, the linear, quadratic or polynomial fit must have R ≥0.995. Where a target compound is ≥15% but ≤30% an average RF may still be used if the analyst shows that the average RF is an acceptable fit over the range of use. Com-pound list will be divided into two lists: List 1 (reliable performers) and List 2 (poor performers). List 1 com-pounds should always have a %RSD less than 30% or correlation coefficient of 0.995 with an allowance of up to 4 sporadic marginal failures. Sporadic marginal failures for these compounds should be ≤40% or 0.990. For List 2 analytes, where the %RSD is ≤15% an average RF will be used. For %RSDs >15% and ≤60% the best fit curve will be selected.	A
Initial calibration verification (ICV)	Analyzed after each initial calibration.	Accuracy	The ICV must be within +/- 30% of its expected value.	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TCL SVOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8270C/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Continuing calibration verification	At the start of each 12-hour period, after the DFTPP	Accuracy	The SPCC compounds must have a response factor of > 0.05. The percent difference or drift of the CCC compounds from the initial calibration must be ≤20%. List 1 compounds that are non-CCC's must be <25% differences or drift with the allowance of up to four which must be ≤40%. List 2 target compounds including Appendix IX will be accepted where the % difference or drift is <50%. Where a List 2 target compound is out high by > 50% and the compound is ND in the samples, the samples may be reported with narration. If a list 1 compound is not found in the sample, a CCV (out high) of up to 50%D or drift, may be accepted with narration subject to determination that it is acceptable for the specific project. Any compound with a %D or Drift >25% must be narrated. The internal standard response must be within 50-200% of the response in the mid level of the initial calibration. The internal standard retention times must be within 30 seconds of the retention times in the mid-level of the initial calibration. If none of the CCCs are required analytes, project specific calibration specifications must be agreed with the client.	A
Method blank	Prepared and analyzed with each batch of 20 or fewer samples.	Sensitivity	The method blank must not contain any analyte of interest at or above the PQL (except common laboratory contaminants, phthalate esters) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher. The method blank must have acceptable surrogate recoveries.	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TCL SVOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8270C/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Instrument blank	During each 12 hour analytical run before samples are analyzed. This may be accomplished by analysis of a method blank. If a method blank is not available, an instrument blank must be analyzed.	Sensitivity	The instrument blank must not contain any analyte of interest at or above the PQL (except common laboratory contaminants, phthalate esters) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher. The instrument blank must have acceptable surrogate recoveries.	A
Laboratory Control Samples (LCS)	Prepared and analyzed with each batch of 20 or fewer samples.	Accuracy	All control analytes must be within established control limits**.**	A
Matrix spike/matrix spike duplicate (MS/MSD)	Prepared and analyzed with every batch of 20 or fewer samples.	Accuracy and precision	Compare the % recovery & RPD to that in the laboratory specific, historically generated limits.	S & A
Performance Testing Sample	Prior to each phase of the study	Accuracy	Results must be within vendor specified acceptance criteria	A
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per lot of source water	Sensitivity	No analytes > PQL	S
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S
Filter Blank (Surface Water only)	1 per lot of filters	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory TBD
Matrix Water
Analytical Group **Mercury**
Sampling Procedure See Worksheet 21
Analytical Method/SOP
Reference SW846 Method 7470B
Concentration Level Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Prior to the analysis of any samples	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Initial calibration	Must be performed daily (every 24 hours) and each time the instrument is set up.	Accuracy	The calibration curve must have a correlation coefficient of ≥0.995	A
Initial Calibration Verification and Initial Calibration Blank (ICV/ICB)	Immediately after the initial calibration.	Accuracy and sensitivity	The ICV result must fall within 10% of the true value for that solution. The ICB result must fall within +/- the PQL from zero.	A
Continuing Calibration Verification and Continuing Calibration Blank (CCV/CCB)	After every 10 samples and at the end of the run.	Accuracy and sensitivity	The CCV result must fall within 20% of the true value for that solution. The CCB result must fall within +/- PQL from zero.	A
Method blank	One method blank must be processed with each preparation batch up to 20 samples.	Sensitivity	The method blank should not contain any analyte of interest at or above the PQL, or above 10% of either the measured concentration of that analyte in associated samples or the regulatory limit.	A
Laboratory control sample (LCS)	One LCS must be processed with each preparation batch up to 20 samples.	Accuracy	In-house control limits are 80 - 120% recovery.	A
Matrix spike/matrix spike duplicate (MS/MSD)	One MS/MSD pair must be processed for each preparation batch up to 20 samples.	Accuracy and precision	Until in-house control limits are established, control limits of 75-125% recovery & 20% RPD must be applied to the MS/MSD.	S & A
Performance Testing Sample	Prior to each phase of the study	Accuracy	Results must be within vendor specified acceptance criteria	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory	TBD
Matrix	Water
Analytical Group	**Mercury**
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 Method 7470B
Concentration Level	Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per lot of source water	Sensitivity	No analytes > PQL	S
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TAL Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6020/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per NELAC certification specifications	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Tuning Standard	Daily	Sensitivity	Analyze the tuning solution containing elements representing all of the mass regions of interest. The relative standard deviations must be $\leq$ 5% after running the tuning solution a minimum of four times.	A
Mass Calibration Check and Mass Resolution Check	Daily	Sensitivity	The mass calibration results must be within 0.1 amu from the true value. The resolution must be verified to be < 0.9 amu full width at 10% peak height.	A
Initial calibration	Daily and each time the instrument is set up.	Accuracy	For a linear multi-point calibration curve, the correlation coefficient must be $\geq$ 0.995. Report the average of at least two integrations for both calibration and sample analysis.	A
Initial Calibration Verification (ICV) [also called Quality control Standard]	Immediately after initial calibration	Accuracy	The ICV must fall within 10% of the true value.	A
Initial Calibration Blank (ICB)	After ICV	Sensitivity	The ICB/CCB must fall within +/- the practical quantitation limit from zero	A
RL Verification Standard	Immediately after the ICV/ICB	Accuracy	The results should be within the range 50-150% recovery for all analytes.	A
Interference Check Solutions (ICSA/ICSAB)	At the beginning of every analytical run and every 12 hours thereafter	Accuracy	Control limits of spiked analytes in the ICSA/ICSAB solution are ± 50% of true value. Control limits of non-spiked analytes are ± two times the practical quantitation limit or less than 1 ug/L.	A
CCV/CCB	After the CRI, following every 10 samples and at the end of the run.	Accuracy and sensitivity	Results for the CCV must be within the range 90-110% recovery. The ICB/CCB must fall within +/- the practical quantitation limit from zero.	A

Laboratory: TBD
Matrix: Water
Analytical Group: **TAL Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6020/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method blank	One method blank must be processed with each preparation batch.	Sensitivity	The method blank must not contain any analyte of interest at, or above, the practical quantitation limit (exception: common laboratory contaminants) or at, or above, 5% of the measured concentration of that analyte in associated samples, whichever is higher (sample result must be a minimum of 20x higher than the blank contamination level).	A
Laboratory Control Samples (LCS)	One LCS from an independent source must be processed with each preparation batch.	Accuracy	All analytes must be within laboratory established historical control limits.	A
Matrix spike/matrix spike duplicate (MS/MSD)	MS/MSD is prepared and analyzed with every batch of samples.	Accuracy and precision	The percent recovery and RPD within the historically generated limits.	A
Post digestion spike (PDS)	If the serial dilution fails to meet the acceptance criteria, a PDS must be performed as follows.	Accuracy	An analytical spike added to a portion of a prepared sample, or its dilution, should be recovered within 75 - 125% of the known value.	A
Serial dilution	One serial five-fold dilution must be analyzed per batch for each matrix.	Accuracy	If the analyte concentration is within linear range of the instrument and sufficiently high (generally, a factor of 100 times above the practical quantitation limit), the serial dilution must agree within 10% of the original analysis.	A
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per each lot of decontamination water or carboy of water	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TAL Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6020/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S
Filter Blank (Surface Water only)	1 per lot of filters	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6010B/ See Worksheet 23
Concentration Level: Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per SOP	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Instrument Detection Limit	Initially and as specified in SOP	Sensitivity	Each measurement must be performed as though it were a separate analytical sample (i.e., each measurement must be followed by a rinse and/or any other procedure performed between the analysis of separate samples).	A
Linear Range	Must be verified every 6 months	Accuracy	The standards used to verify the linear range limit must be analyzed during a routine analytical run, and must read within 10% of the expected value.	A
Initial calibration	Daily and each time the instrument is set up.	Accuracy	Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures.	A
Initial Calibration Verification (ICV)	Immediately after initial calibration	Accuracy	The ICV must fall within 10% of the true value for that solution. For Method 6010B, the relative standard deviation must be $\leq$5% from replicate (minimum of two) exposures.	A
Initial Calibration Blank (ICB)	After ICV	Sensitivity	The ICB/CCB must fall within +/- the practical quantitation limit from zero	A
Interference Check Solutions (ICSA/ICSAB)	At the beginning of every analytical run	Accuracy	The ICSAB results for the interferents must fall within 80 - 120% of the true value. If any ICSAB interferent result fails criteria, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the samples rerun. ICSA results for the non-interfering elements with practical quantitation limits ≤ 10 ug/L must fall within ± 2 times the PQL from zero. ICSA results for the non-interfering elements with PQLs > 10 µg/L must fall within ± 1 times the PQL from zero	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6010B/ See Worksheet 23
Concentration Level: Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
CRI (Practical quantitation limit standard)	At the beginning of every analytical run	Accuracy and sensitivity	Evaluate associated samples based upon advisory limits of ± 50% of true value.	A
CCV/CCB	After the ICV/ICB, following every 10 samples and at the end of the run.	Accuracy and sensitivity	Results for the CCV must be within the range 90-110% recovery. For Methods 6010B, and 200.7, the relative standard deviation must be ≤5% from replicate (minimum of two) exposures. The ICB/CCB must fall within +/- the practical quantitation limit from zero.	A
Method blank	One method blank must be processed with each preparation batch.	Sensitivity	The method blank must not contain any analyte of interest at, or above, the practical quantitation limit (exception: common laboratory contaminants) or at, or above, 5% of the measured concentration of that analyte in associated samples, whichever is higher (sample result must be a minimum of 20x higher than the blank contamination level).	A
Laboratory Control Samples (LCS)	One LCS must be processed with each preparation batch.	Accuracy	Unless in-house control limits are established, a control limit of 80 - 120% recovery must be applied.	A
Matrix spike/matrix spike duplicate (MS/MSD)	MS/MSD is prepared and analyzed with every batch of samples.	Accuracy and precision	Control limits of 75-125% recovery and 20% RPD or historical acceptance criteria must be applied to the MS/MSD.	A
Dilution test	One sample per preparation batch must be processed as a dilution test	Accuracy	The results of the diluted sample after correction for dilution must agree within 10% of the original sample determination when the original sample concentration is greater than 50 times the IDL.	A
Field Duplicate	1 per 20 Samples	Precision	Relative Percent Difference (RPD) <30% for surface water.	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6010B/ See Worksheet 23
Concentration Level: Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Source Blank	1 per each lot of decontamination water or carboy of water	Sensitivity	No analytes > PQL	S
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S

Practical Quantitation limit (PQL) is the same as the reporting limit (RL).

CCC = calibration check compounds
CFR = Code of Federal Regulations
DQI = data quality indicator
ICB = initial calibration blank
ICV = initial calibration verification
LCS = laboratory control sample
MDL = method detection limit
MS/MSD = matrix spike/matrix spike duplicate
NELAP = National Environmental Laboratory Accreditation Program
PQL = practical quantitation limit (same as reporting limit)
QC = quality control
RF = response factor
RPD = relative percent difference
RSD = relative standard deviation
SOP = standard operating procedure
SPCC = system performance check compounds
SVOC = semi-volatile organic compound
TAL = target analyte list

TBD = to be determined
TCL = target compounds list
VOC = volatile organic compound

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Chemical and physical characterization of non-native sediments for location 01A through 106D.	**GEI Consultants** for KeySpan Corporation *Remedial Investigation (RI) Technical Report, April 2007*	**GEI Consultants** Sediment samples (279) were collected between 2005 and 2006 analyzed for the following chemical and physical parameters using methods indicated in parentheses: VOCs (EPA 8260B) SVOCs (EPA 8270C) TAL metals Cyanide (EPA 9012) PCBs (EPA 8082A) Pesticides (EPA 8081A) Herbicides (EPA 8151A) TOC (EPA 9060) Anions (sulfate, nitrate, nitrite) (EPA 300.0) bulk density (ASTM D2937) water content (ASTM D2216) grain size (ASTM 4464-00). A subset (104) of these samples were also analyzed for polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH).	For Phase 2 RI/FS to assist in defining the nature and extent of sediment contamination in the Canal.	None
Geophysical survey	**GEI Consultants** for KeySpan Corporation *Remedial Investigation Technical Report, April 2007*	**Ocean Surveys Inc.** for GEI Consultants Side scans and magnetometer surveys of the Gowanus Canal were conducted between October and November 2005	For identifying obstructions in the Canal and areas of debris	All debris in the Canal may not have been accounted for by the surveys; Since the surveys were conducted, additional debris may have deposited in the Canal.

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Sediment core logs	**GEI Consultants** for KeySpan Corporation *Remedial Investigation Technical Report,* *April 2007*	**GEI Consultants** Sediment coring logs describe information collected between December 2005 and January 2006 on sediment types and depths in the Gowanus Canal	For estimating thickness of soft sediment, depth between soft sediments and underlying native sediments, depth of vibracore refusal, and presence of non-aqueous phase liquid (NAPL) in sediments	Changes may have occurred in the thickness of soft sediment and distribution of NAPL may have changed since 2005-2006; Locations of new cores may not be exactly the same as the locations of previous cores
Canal Investigation, 2005 - 2006	**GEI Consultants**, *Gowanus Canal Investigation*, 2009	**GEI Consultants** Samples (100) of surficial sediments were collected and analyzed from October to November 2005. Sediment cores (103) were advanced and sediment samples (279) were collected and analyzed between December 2005 and January 2006. Borings (5) were advanced adjacent to the Canal and subsurface samples (10) were collected and analyzed in June 2006. Surface water samples (138), outfall discharge samples (56) and outfall sediment samples (10) were also collected and analyzed	For supplementing background information to enhance conceptual understanding	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Bathymetric survey	**CR Environmental, Inc.** for HDR *Bathymetric Survey Report, April 2010* EPA RI Report Appendix B, 2010	**CR Environmental, Inc.** for HDR Bathymetry survey was conducted in January 2010 and measurements of depth/ elevation, water column temperature, and conductivity were collected to generate map of seabed elevations and morphometry.	For tasks associated with Canal bottom reconnaissance and debris remove	Since the surveys were conducted, changes in bathymetry of the Canal may have occurred.

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Field Documentation	**CH2M HILL** For EPA *Field Documentation, 2010* EPA RI Report Appendix D	**AquaSurvey, Inc. for CH2M HILL** Conducted a Sediment Investigation Survey in which sediment cores were collected during March and April 2010 from 88 previously sampled transect locations,21 new transect locations, 17 new non-transect locations, and 9 contingency sampling locations. Samples were analyzed for VOCs, SVOCs, pesticides, PCBs, total metals, mercury, cyanide, TOC, total sulfide, and grain size Elevation of sediment surface was additionally determined Samples for waste characterization were collected from 22 cores along with two composite samples of investigation derived waste. These were analyzed for toxicity characteristic leaching procedure (TCLP), reactivity, corrosively, and ignitibility Sediment core logs described additional information on sediment composition Surface sediment and water sampling forms, and soil boring logs provide additional information	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Tidal survey	**CH2M HILL** For EPA *Evaluation of Results of Tidal Survey* EPA RI Report Appendix E, 2010	**CH2M HILL** Tidal survey was conducted at 6 stations in August 2010 to obtain measurements of tidal fluctuations, groundwater levels, and barometric pressure	For evaluating potential groundwater upwelling at Canal bottom and for staging site selection	None
Groundwater / surface water interaction	**CH2M HILL** For EPA *Evaluation of Groundwater / Surface Water Interaction* EPA RI Report Appendix F, 2010	**National Grid, New York City, and EPA** Groundwater samples from 14 shallow and intermediate monitoring wells and surface water samples from 8 adjacent stations were collected from June to July 2010. Samples were analyzed for metals and general water quality parameters	For evaluating potential groundwater upwelling at Canal bottom	None
Outfall survey	**CH2M HILL** For EPA *Survey of Outfall Features to the Gowanus Canal* EPA RI Report Appendix G, 2010	**CH2M HILL** Phase 1 and phase 2 surveys were conducted and information regarding outfall features and active discharges to the Gowanus Canal were collected. 12 features were sampled for additional information	For staging site selection and bulkhead assessment	Additional data may be needed to characterize discharge under different conditions and determine the origin of the outfalls

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	**How Data Will Be Used**	**Limitations on Data Use**
Analytical data	**CH2M HILL** For EPA *Analytical Data* EPA RI Report Appendix I, 2010	**CH2M HILL** Data on concentrations of VOCs, SVOC, PCBs, pesticides, metals, cyanide, TOC, sulfide, TCLP, and physical characteristics such as grain size of soft and native sediments in the Gowanus Canal Data on similar measurements obtained for surface water and groundwater including geochemical measurements Data on similar measurements obtained for pipe outfalls, and combined sewer overflow sediments Data on concentrations of VOCs, SVOCs, PAHs, and PCBs in air samples Data on concentrations of VOCs, SVOC, PCBs, pesticides, metals, and cyanide in aquatic organisms in the Canal	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	None

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Ecological risk assessment	**CH2M HILL** For EPA *Ecological Risk Assessment* EPA RI Report Appendix K, 2010	**CH2M HILL** Concentrations of VOCs, SVOC, PCBs, pesticides, metals, and cyanide were measured in sediments and in crab and fish samples collected during the Phase 3 Investigation and used in Baseline Ecological Risk Assessment. Additionally, sediment samples were analyzed for acid volatile sulfide and simultaneously extractable metals		Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling
Human risk assessment	**CH2M HILL** For EPA *Human Health Risk Assessment* EPA RI Report Appendix L, 2010	**CH2M HILL** Surface sediment and water samples were collected between Jun and July 2010 and analyzed for constituents in TCL and TAL. Additional sediment samples were collected for PCB analysis Ambient air samples were collected in July 2010 and analyzed for VOCs, PAHs, and PCBs Fish and crab tissue samples were collected between June and July 2010	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Bulk head study and side Scan Sonar	**HDR, Inc.** For EPA *Historic Preservation, December 2010* EPA RI Report Appendix M, 2010	**John Milner Associates, Inc.** for HDR, Inc. and EPA, December 2010 Information on types of bulkheads that line the Gowanus; information of bulkhead preservation and mitigation strategies. **Dolan Research, Inc.** for HDR, Inc. and EPA Side scan sonar data were collected and assessed for Site conditions, obstruction, anomalies, and potential submerged cultural resources	For bulkhead survey and assessment and debris reconnaissance	Data on bulkhead conditions below the water line were not collected; Areas of the Canal were not surveyed during debris reconnaissance
Sediment depth profiles	**CH2M HILL** For EPA *Sediment Core Depth Profiles* EPA RI Report Appendix N, 2010	**CH2M HILL** Depth profiles of totals PAHs, total PCBs, and lead in sediment cores	For evaluating potential areas of potentially mobile NAPL	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling
Soil and groundwater analytical result summaries for properties along the Canal	**CH2M HILL** For EPA *Upland Investigation Summary* EPA RI Report Appendix O, 2010	**CH2M HILL** Soil and groundwater samples were collected from properties adjoining the Canal and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	None

NAPL = non-aqueous phase liquid
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
RI = Remedial Investigation
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TCL = Target Compound List
TCLP = toxicity characteristic leaching procedure
TOC = total organic carbon
TPH = total petroleum hydrocarbon
VOC = volatile organic compound

QAPP Worksheet #14 - Summary of Project Tasks

QAPP Worksheet #14a – PD-3: Additional Debris Reconnaissance

QAPP Worksheet #14b – PD-4: Development of Debris Removal and Management Plan

QAPP Worksheet #14c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

QAPP Worksheet #14d – PD-6: Staging Site Selection and Implementation Plan

QAPP Worksheet #14e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

QAPP Worksheet #14f – PD-8: Evaluation of NAPL Mobility in Native Sediments

QAPP Worksheet #14 - Summary of Project Tasks (continued)

PD-3: Additional Reconnaissance for Debris Removal

Sampling Tasks:

High frequency side-scan sonar of the full length of the Canal. See Worksheet #18 for sample locations

Analytical Tasks:

No analytical samples will be collected.

Quality Control (QC) Tasks:

All applicable QC criteria for calibration of instrumentation will be followed per the manufacturer's instructions and/or relevant standard operating procedures (SOPs). QC activities will be documented in field forms and/or field log books.

Secondary Data:

Previous data reports and spreadsheets. See Worksheet #13.

Data Management Tasks:

Data are generated primarily though field activities. Data are entered into in electronic format in accordance with the project protocols.

Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file.

Hard copies of field forms and data are filed in a secure storage area. Project data will be archived for 15 years in an electronic format.

Documentation and Records:

In association with field data collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples as applicable. All hard copy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files.

Assessment/Audit Tasks:

Review of SOPs relating to field and project activities is required prior to project start.

Data Review Tasks:

Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer.

QAPP Worksheet #14 - Summary of Project Tasks (continued)

PD-4: Development of Debris Removal and Management Plan

Sampling Tasks: Not applicable.
Analytical Tasks: No analytical samples will be collected.
QC Tasks: Not applicable.
Secondary Data: Results of work done in PD-3, previous data reports, and spreadsheets. See Worksheet #13.
Data Management Tasks: Not applicable
Documentation and Records: Not applicable
Assessment/Audit Tasks: Not applicable
Data Review Tasks: Peer and senior review of all documentation will occur prior to issuance of the final plan. Senior and peer reviews are documented with the date and signature of the reviewer.

PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

Sampling Tasks:

- Subsurface Investigation of Existing Bulkhead Foundations
- Geotechnical Site Investigation

See Worksheet #18 for sample locations

Analytical Tasks:

- Geotechnical borings with disturbed and undisturbed sample recovery, standard penetrometer test blow count measurements (ASTM D1586), and geotechnical visual soil classifications (ASTM D2487/D2488);
- CPT soundings (ASTM D5778) with shear wave testing performed at select locations (ASTM D7400);
- Crosshole seismic testing (ASTM 4428) at select locations;
- Downhole seismic testing (ASTM D7400) at select locations;
- Induction testing (adaptation of ASTM 5753 and ASTM 6726) at select locations;
- Low strain impact integrity testing (ASTM D5882) at select locations; and
- Geotechnical laboratory testing.
  - Moisture contents (ASTM D2216);
  - Atterberg Limits (ASTM D4318);
  - Unit weight (ASTM D7263);
  - Grain size distribution (ASTM D422);
  - Consolidated undrained triaxial shear testing (ASTM D4767); and
  - Undrained unconsolidated shear testing (ASTM D2850).

QC Tasks:

All testing will be performed according to the applicable methodology or SOP incorporating the QC measurements associated with the specific test. QC measurement results shall fall within the specified acceptance criteria.

Secondary Data:

Previous data reports and spreadsheets. See Worksheet #13.

Data Management Tasks:

Data are generated from two primary pathways: i) data derived from field activities; and ii) geotechnical laboratory data. Data are entered into in electronic format in accordance with the project protocols.

Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file.

Data generated during geotechnical analysis are recorded in hard copies, electronic reports in pdf format, and in electronic data deliverables (EDDs) after the samples have been analyzed.

Hard copies of field forms, data, and chain of custody forms are filed in a secure storage area. Laboratory data packages and reports are archived at Contractor offices for 15 years. Laboratories that generated the data archive data for a minimum of 5 years.

Documentation and Records: In association with sample collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples. All hardcopy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files.
Assessment/Audit Tasks: Review of SOPs relating to field, lab, data validation, and project activities is required prior to project start. Audit records and accreditations of the laboratories are maintained by the laboratory and available upon request.
Data Review Tasks: Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer. All engineering reports will be reviewed and stamped by the engineer of record.

QAPP Worksheet #14 - Summary of Project Tasks (continued)

PD-6: Staging Site Selection and Implementation Plan

Sampling Tasks: No samples will be collected during this task.
Analytical Tasks: No analytical samples will be collected.
QC Tasks: Not applicable.
Secondary Data: Previous data reports and spreadsheets. See Worksheet #13.
Data Management Tasks: Not applicable
Documentation and Records: Not applicable
Assessment/Audit Tasks: Not applicable
Data Review Tasks: Peer and senior review of all documentation will occur prior to issuance of the final plan. Senior and peer reviews are documented with the date and signature of the reviewer.

QAPP Worksheet #14 - Summary of Project Tasks (continued)

PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

Sampling Tasks:

- Implement selected Site characterization technologies to assess upwelling areas and groundwater discharge rates.

See Worksheet #18 for sample locations

Analytical Tasks:

No analytical samples are anticipated for collection during this task.

QC Tasks:

All measurements and QC will be performed in accordance with specific methodologies adapted for each technology.

Secondary Data:

Previous data reports and spreadsheets. See Worksheet #13.

Data Management Tasks:

Data are generated primarily though field activities. Data are entered into in electronic format in accordance with the project protocols. Electronic data collected by subcontractors or field personnel during technology implementation will be backed up to secure project directories as soon as possible.

Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file.

Hard copies of field forms and data are filed in a secure storage area. Project data will be archived for 15 years in an electronic format.

Documentation and Records:

In association with sample collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples. All hardcopy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files. Electronic files will be saved to a secure project directory.

Assessment/Audit Tasks:

Review of SOPs relating to field and project activities is required prior to project start.

Data Review Tasks:

Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer.

PD-8: Evaluation of Non-Aqueous Phase Liquid (NAPL) Mobility in Native Sediments

Sampling Tasks:

- Implementation of field-based approaches to assess in situ NAPL distribution.
- Collection of undisturbed sediment cores for confirmatory laboratory analysis to assess the NAPL distribution in native sediments of the Canal.
- Collection of NAPL from native sediments.
- Collection of groundwater samples from native sediments.
- Laboratory mobility testing to assess mobility of NAPL within the sediments.

See Worksheet #18 for sample locations

Analytical Tasks:

- Sediment cores will be analyzed for the following:
  - NAPL pore fluid saturation at set vertical spacing, which will be collocated with field-based assessments;
  - Centrifuge and/or water flood of sediment samples to assess NAPL residual saturation and mobility potential;
  - Drainage capillary pressure data (i.e., water retention curves) to understand the soil matrix and to develop the parameters to understand pore entry pressures;
  - Potential photography of the core under white and ultraviolet light to provide an understanding of the vertical NAPL distribution and aid in defining vertical depths for further mobility assessment; and
  - Geotechnical parameters to confirm the field-based approach for soil/sediment texture observations.
- Collected NAPL and groundwater samples will be analyzed for density, viscosity, and interfacial tension. The collected NAPL will also be analyzed for contaminants as specified in Worksheet #15.
- Laboratory mobility testing (test specifics to be determined during desktop evaluation)

QC Tasks:

All applicable QC protocols will be performed according to the methodology and the SOPs. All specified QC criteria will be met and documented.

Secondary Data:

Previous data reports and spreadsheets. See Worksheet #13.

Data Management Tasks: Data are generated from three primary pathways: i) data derived from field activities; ii) laboratory analytical data; and iii) validated data. Data from all three pathways are entered into an electronic format in accordance with the project protocols. Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file. Data generated during laboratory analysis are recorded in hard copies, electronic reports in pdf format, and in EDDs after the samples have been analyzed. These data are then submitted for data validation. Data validation is performed in accordance with Worksheets #33, #34, #35, #36, and #37. Hard copies of field forms, data, and chain of custody forms are filed in a secure storage. Laboratory data packages and reports are archived at Contractor offices for 15 years. Laboratories that generated the data archive data for a minimum of 5 years.
Documentation and Records: In association with sample collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples. All hardcopy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files.
Assessment/Audit Tasks: Review of SOPs relating to field, lab, data validation, and project activities is required prior to project start. Audit records of the laboratories are maintained by the laboratory and available upon request.
Data Review Tasks: Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer. Laboratory data will undergo data validation and verification.

EDD = electronic data deliverable
NAPL = non-aqueous phase liquid
QC = quality control
SOP = standard operating procedure

Laboratory: TBD
Matrix: Water
Analytical Group: TCL VOCs/8260
Concentration Level: Low

					Analytical Method[2]		Achievable Lab Limits	
Analyte	**CAS Number**	**Marine Water Project Action Limit (µg/L)[1]**	**Fresh Water Project Action Limit (µg/L)[1]**	**Project Quantitation Limit (µg/L)**	**MDLs**	**Method QLs**	**MDLs (µg/L)**	**QLs (µg/L)**
Benzene	71-43-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromobenzene	108-86-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromochloromethane	74-97-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromodichloromethane	75-27-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromoform	75-25-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromomethane	74-83-9	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
n-Butylbenzene	104-51-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
sec-Butylbenzene	135-98-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
tert-Butylbenzene	98-06-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Carbon tetrachloride	56-23-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chlorobenzene	108-90-7	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chlorodibromomethane	124-48-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chloroethane	75-00-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chloroform	67-66-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chloromethane	74-87-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
2-Chlorotoluene	95-49-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
4-Chlorotoluene	106-43-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dibromo-3-chloropropane	96-12-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dibromoethane	106-93-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Dibromomethane	74-95-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dichlorobenzene	95-50-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,3-Dichlorobenzene	541-73-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,4-Dichlorobenzene	106-46-7	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Dichlorodifluoromethane	75-71-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1-Dichloroethane	75-34-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dichloroethane	107-06-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1-Dichloroethene	75-35-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
cis-1,2-Dichloroethene	156-59-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
trans-1,2-Dichloroethene	156-60-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dichloropropane	78-87-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
2,2-Dichloropropane	594-20-7	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,3-Dichloropropane	142-28-9	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1-Dichloropropene	563-58-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD

Laboratory: TBD
Matrix: Water
Analytical Group: TCL VOCs/8260
Concentration Level: Low

					Analytical Method[2]		Achievable Lab Limits	
Analyte	CAS Number	Marine Water Project Action Limit (μg/L)[1]	Fresh Water Project Action Limit (μg/L)[1]	Project Quantitation Limit (μg/L)	MDLs	Method QLs	MDLs (μg/L)	QLs (μg/L)
Ethylbenzene	100-41-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Hexachlorobutadiene	87-68-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Isopropylbenzene	98-82-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
p-Isopropyltoluene	99-87-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Methylene chloride	75-09-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Naphthalene	91-20-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
n-Propylbenzene	103-65-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Styrene	100-42-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,1,2-Tetrachloroethane	630-20-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,2,2-Tetrachloroethane	79-34-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Tetrachloroethene	127-18-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Toluene	108-88-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,4-Trichlorobenzene	120-82-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,3-Trichlorobenzene	87-61-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,1-Trichloroethane	71-55-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,2-Trichloroethane	79-00-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Trichloroethene	79-01-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Trichlorofluoromethane	75-69-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,3-Trichloropropane	96-18-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,4-Trimethylbenzene	95-63-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,3,5-Trimethylbenzene	108-67-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Vinyl chloride	75-01-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
o-Xylene	95-47-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
m-Xylene	108-38-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
p-Xylene	106-42-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Methyl-t-butyl ether	163-40-44	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Dichlorofluoromethane	75-43-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD

[1]These compounds will be analyzed according to the method, but results will not be compared to any reference standards at this time.
[2]Analytical method MDLs and QLs are those documents in published methods shown.

QAPP Worksheet #16 - Project Schedule Timeline Table

The Work Plans for pre-design work elements PD-3 through PD-8 are subject to review and approval by the EPA Region 2 Project Team. The drafts of these Work Plans are to be shared with the EPA Project Team for their input and concurrence prior to finalization. Implementation and completion of the PDWP activities will be performed under a Unilateral Administrative Order (UAO) by a group of potentially responsible parties (PRP Group) identified by the EPA. Coordination of work amongst responsible parties needs to be finalized before a workable schedule can be finalized.

	Anticipated Project Dates			
Activities	**Initiation**	**Completion**	**Deliverable**	**Deliverable Due Date**
Submission of Pre-Design Work Plan (PDWP)	N/A	N/A	PDWP	1/28/14
Submission of Remedial Design Work Plans (RDWP)	N/A	N/A	RDWP	2/27/14
Submission of QAPP and Field Sampling Plan (FSP)	N/A	N/A	QAPP	2/27/14
Submission of Health and Safety Plan (HASP)	N/A	N/A	RDWP	2/27/14
A work flow schedule for currently identified pre-design and remedial design activities is included in the Remedial Design Work Plan. Please refer to Geosyntec Consultants, February 2014. “Remedial Design Work Plan, Gowanus Canal, Brooklyn, New York.”				

QAPP Worksheet #17 – Sampling Design and Rationale

QAPP Worksheet #17 – Sampling Design and Rationale

The following worksheets describe the sampling program rationale and design. Specific sampling and collection details are provided in:

- Worksheet (WS)#15 – Reference Limits and Evaluation Table;
- WS#18 – Sampling Locations and Methods/SOP Requirements Table;
- WS#20 – Field Quality Control Sample Summary Table; and
- WS#21 – Project Sampling SOP Reference Table.

QAPP Worksheet #17a – PD-3: Additional Debris Reconnaissance - Sampling Design and Rationale

QAPP Worksheet #17b – PD-4: Development of Debris Removal and Management Plan - Sampling Design and Rationale

QAPP Worksheet #17c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation - Sampling Design and Rationale

QAPP Worksheet #17d – PD-6: Staging Site Selection and Implementation Plan – Sampling Design and Rationale

QAPP Worksheet #17e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates - Sampling Design and Rationale

QAPP Worksheet #17f – PD-8: Evaluation of NAPL Mobility in Native Sediments - Sampling Design and Rationale

QAPP Worksheet #17a - PD-3: Additional Debris Reconnaissance - Sampling Design and Rationale

Sampling Rationale
Visual observations and instrumentation readings per instrument protocol.
Sampling Design
The full length of the Canal will be examined per field instrumentation protocol.

QAPP Worksheet #17 – Sampling Design and Rationale (continued)

QAPP Worksheet #17b – PD-4: Development of Debris Removal and Management Plan - Sampling Design and Rationale

Sampling Rationale

Not Applicable

Sampling Design

Not Applicable

QAPP Worksheet #17c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation - Sampling Design and Rationale

Sampling Rationale

Subsurface Investigation of Existing Bulkhead Foundations

A Bulkhead Investigation will be performed to evaluate the depth and elevation of the bulkhead foundations along the length of Gowanus Canal (Canal). Prior to a Site-wide implementation of the Bulkhead Investigation, a methods development program will be performed to evaluate the feasibility and relative accuracy of investigation methods being considered for determining the location of the bottom of the bulkheads. Investigation methods being considered include: (i) downhole seismic testing; (ii) crosshole seismic testing; (iii) induction testing; and (iv) and low strain impact testing. These investigation methods are evaluated through tests at select locations where the depth to bottom of the bulkhead is known. Whichever methods are found to be most accurate in evaluating the depth to the bottom of the bulkhead foundations will be implemented Site-wide.

The selected investigation methods will be implemented at frequencies (discussed below) to allow for a comprehensive understanding of the typically implemented bulkhead construction practices along the Canal. Understanding previous design practices will allow for relatively accurate estimates of bulkhead foundation depths where access for bulkhead exploration is not possible.

Geotechnical Site Investigation

A Geotechnical Investigation will be performed to evaluate design soil properties and parameters and to develop subsurface stratigraphy along the length of the Canal. The selected locations and frequency of Geotechnical Investigation borings and Cone Penetrometer Testing (CPTs) will allow for the development of a subsurface geotechnical model to aid in evaluating existing wall conditions, analyzing temporary systems, and developing design of permanent wall systems. The selected investigation frequency will seek to capture variations in the geotechnical subsurface with enough redundancy so that borings can be shifted or eliminated if there are any unavoidable physical obstructions or access limitations.

Sampling Design

Subsurface Investigation of Existing Bulkhead Foundations

Sample locations for the Bulkhead Investigation will be attempted (i) wherever an upland geotechnical boring can be performed within 5 feet (ft) of the bulkhead edge allowing for either downhole seismic testing or induction testing; or (ii) wherever an investigation point can be accessed within 5 ft of the bulkhead edge from the Canal-side of the bulkhead, allowing for either downhole seismic testing, crosshole seismic testing, or induction testing. A Bulkhead Investigation will be performed as access allows at an approximate frequency of one investigation point per 100 ft of bulkhead length. The selected investigation methods for each bulkhead type will be based the results of the methods development program completed prior to this task. Where access is available and if the method is determined to be effective, low strain impact testing may be performed on select bulkheads if the method.

Bulkhead Investigation testing may be eliminated at some locations if research and review of as-builts and design reports of existing bulkheads become available.

Geotechnical Site Investigation

Sampling locations will be selected at approximately 100 ft intervals along the length of the bulkheads. Sampling locations will consist of two points oriented perpendicularly to the bulkhead under investigation with one sample collected approximately 10 ft laterally from the bulkhead and one sample collected approximately 50 ft laterally from the bulkhead:

- One “shallow” boring will be collected to a depth 10 ft deeper than the estimated bottom of the bulkhead based on the desktop study. These borings will be offset approximately 10 ft laterally

from the bulkhead so that they pass through fill material.
- One CPT sounding will be attempted to a target depth of 70 ft bgs except where "deep" borings will be performed. CPT locations will be offset approximately 50 ft laterally from the bulkhead in line with the "shallow" borings. If a CPT cannot be completed to the target depth, then the boring depth will be altered to match that of the nearby "shallow" sample. Shear wave testing will be performed at select CPT locations.
- One "deep" boring will be collected to a target depth of 70 ft. These borings will be collected in place of CPT samples approximately every 400 ft along the length of the bulkheads and will be offset approximately 50 ft laterally from the bulkhead.

The second investigation point is designed so that a soil profile perpendicular to the bulkhead can be generated for use in design. Note that upland borings close to the bulkhead will be referred to as "shallow" borings and borings further from the bulkhead will be referred to as "deep" borings.

Target depths for the "shallow" borings will be 10 ft below the assumed foundation of the bulkhead based on the desktop study. The target depth of the "deep" borings and CPTs will be 70 ft. This is designed such so as to encounter and identify the depth of target soil layers for developing anchor design. Target depths may be adjusted in the field based on observed conditions during the Investigation.

<u>Sampling Locations</u>

Target Geotechnical Investigation borings and CPTs locations will be laid out on a location map based on spacing rules discussed above and to account for any known obstructions or access limitations. However, it is expected that there will be physical impediments to reaching some of the selected locations. The Field Engineer retains the right to select the final test locations. If needed, upland investigation points may be moved up to 25 ft from the original target location while maintaining the intent and function of the investigation point. Investigation points on the Canal-side of the bulkhead will be limited to 5 ft while maintaining the intent and purpose of the investigation point. If an investigation point cannot be relocated within the stated limits, then it will be abandoned.

If a CPT encounters an obstruction prior to reaching the target depth, then one CPT reattempt (located within 3 to 5 ft of the original location) will be performed, if possible. If a reattempt is not possible or the reattempt encounters an obstruction prior to reaching target depth, then the CPT may be replaced with a boring (located within 5 ft of the original location) or abandoned, at the discretion of the Field Engineer. If a boring encounters early refusal, then the boring will be reattempted within 5 ft of the original location. If the second boring encounters early refusal, no additional exploration will be performed and the investigation location will be abandoned. Any recovered samples or data will be included in the geotechnical models.

Disturbed soil samples will be recovered and standard penetration test blow counts will be recorded on a regular basis. Undisturbed samples will be selected in the field based on observed soil conditions, and one undisturbed sample will be attempted per each cohesive soil strata encountered within the anticipated zone of influence at each upland boring location.

Geotechnical Investigation points may be eliminated if research and review of as-builts and design reports of existing bulkheads become available.

QAPP Worksheet #17d – PD-6: Staging Site Selection and Implementation Plan – Sampling Design and Rationale

Sampling Rationale

Not Applicable

Sampling Design

Not Applicable

QAPP Worksheet #17e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates - Sampling Design and Rationale

Sampling Rationale

To collect a sufficient amount of data to adequately identify areas of groundwater upwelling and characterize groundwater discharge rates in representative areas within Gowanus Canal.

Sampling Design

Sampling design for collecting groundwater discharge rate data will be determined based upon the results from surveys that identify potential areas of groundwater upwelling and locations deemed feasible for implementing technologies capable of assessing groundwater discharge rates.

QAPP Worksheet #17f – PD-8: Evaluation of Non-Aqueous Phase Liquid (NAPL) Mobility in Native Sediments - Sampling Design and Rationale

Sampling Rationale

Implementation of field-based approaches selected as appropriate from a desktop evaluation to assess in situ NAPL distribution

The field-based approaches will incorporate technologies selected from the desk-top evaluation to measure the presence of NAPL in situ. Specifically, sub-tasks anticipated to be performed are as follows:

1. Field-based approaches to assess NAPL distribution in native sediments in the Canal in concert with characterization of sediment texture and geotechnical parameters (e.g., CPT) at all locations;
2. Collection of undisturbed sediment cores for confirmatory laboratory analysis to assess the NAPL distribution in native sediments of the Canal from a sub-set of the sampling locations;
3. Collection of undisturbed sediment cores for performance of laboratory mobility testing from the areas of highest observed NAPL saturation based upon field methods; and
4. Collection of groundwater and NAPL samples from the native sediment.

NAPL characterization and laboratory mobility testing

The goal of the laboratory analysis of undisturbed sediment cores is to understand (i) the vertical seepage velocity, among other factors, that is necessary to cause upward migration of the NAPL within the native sediments, and (ii) the confining pressure needed to impede this migration if it exists. The scope of work for the laboratory mobility testing includes (i) characterization analyses of the collected sediment core, NAPL, and groundwater samples, and (ii) empirical assessment of potential vertical NAPL mobility.

Sampling Design

Results of the desktop evaluation will be used to focus the application of field-based approaches to locations which are anticipated to have the highest likelihood of vertical upward NAPL migration and/or the highest anticipated NAPL saturation. Within the focused areas, a series of smaller, initial target areas will be defined by the existing 3-D data distribution as initial areas of deployment to assess the efficacy of field-based approaches and laboratory analysis programs. Following the successful completion of the initial deployment, the approach will be expanded to the larger objective of delineating and/or defining the areas of migrating NAPL below the Canal for remedy implementation.

For the NAPL distribution assessment, the coring device will be advanced to capture the profile of observed TarGOST® readings above background, which is anticipated to be approximately 10 ft of material below the soft sediments/native sediments interface. The actual length of core collected will depend upon the TarGOST® readings and may be more or less than 10 ft. A subset of these collected cores will be used to assess the NAPL mobility using the material below the soft sediments/native sediments interface in the zone of highest observed TarGOST® response. If necessary, an additional undisturbed sediment core will be collected for the NAPL mobility assessment to minimize sample disturbance prior to testing.

Where possible, samples of NAPL and groundwater will be collected from the native sediments in the general vicinity of the sediment sampling area. Groundwater and NAPL samples will be collected by advancing a temporary well into the native sediments and allowing sufficient media to collect inside the screen prior to sampling. Methods for temporary well advancement and sampling will be specified in a forthcoming SOP.

CPT = cone penetrometer testing
ft = feet
NAPL = non-aqueous phase liquid
SOP = standard operating procedure
Worksheet = WS

QAPP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (identify field dups)	Sampling SOP Reference[1]	Rationale for Sampling Location
Laboratory NAPL Characterization Samples	Sediment	TBD	API RP40 (pore fluid sat., permeability product, permeability/conductivity), [Centrifuge], ASTM D6386, ASTM D5079, ASTM D4222, ASTM D4318	N/A	TBD	TBD	TBD
Laboratory NAPL Mobility Testing	Sediment	TBD	TBD	N/A	TBD	TBD	TBD
NAPL from Native Sediments	NAPL	TBD	Density (ASTM D1217), viscosity (ASTM D445), and interfacial tension (ASTM D971), TCL VOCs (8260B), TCL SVOCs (8270C), and TAL metals (6010C/6020A)	N/A	TBD	TBD	TBD
Groundwater from Native Sediments	Groundwater	TBD	Density (ASTM D1217), viscosity (ASTM D445), and interfacial tension (ASTM D971), TCL VOCs (8260B), TCL SVOCs (8270C), and TAL metals (6010C/6020A)	N/A	TBD	TBD	TBD
Bulkhead foundation investigation testing, typically performed from the Canal-side of the bulkhead, approximately 5 ft from the bulkhead edge (at select bulkheads TBD)	Bulkhead material	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	Divers, downhole seismic testing (ASTM D7400), crosshole testing (ASTM D4428), low strain impact integrity testing (ASTM D5882), Induction testing (ASTM D6726 and ASTM D5753)	N/A	One test per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions.	SOP for divers TBD, ASTM D7400, ASTM D4428, ASTM D5882, adaptation of ASTM D6726 and ASTM D5753 TBD	Need to understand the depth of foundation for all bulkheads as all are constructed differently

QAPP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (identify field dups)	Sampling SOP Reference[1]	Rationale for Sampling Location
Bulkhead foundation investigation borings, typically performed from the Canal-side of the bulkhead, approximately 5 ft from the bulkhead edge (at select bulkheads TBD)	Subsurface soils	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	UU triaxial (ASTM D2850), CU triaxial (ASTM D4767), moisture content (ASTM D2216), unit weight (ASTM D7263), Atterberg limit (ASTM D4318), grain size (ASTM D422), USCS classification (ASTM D2487)	N/A	One boring to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions. Soils samples selected for testing TBD by the Engineer after boring completion.	ASTM D2850, ASTM D4767, ASTM D2216, ASTM D7263, ASTM D4318, ASTM D422, ASTM D2487	Bulkhead foundation investigation borings needed as part of the borehole preparation for the bulkhead foundation investigation testing
Bulkhead foundation investigation CPTs, typically performed from the Canal-side of the bulkhead, approximately 5 ft from the bulkhead edge (at select bulkheads TBD)	Subsurface soils	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	CPT sounding (ASTM D5778)	N/A	One CPT to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions.	ASTM D5778	Bulkhead foundation investigation CPT needed as part of the bulkhead foundation investigation testing
Geotechnical investigation “shallow” borings performed upland of bulkheads, approximately 10 ft from bulkhead edge (attempted at all bulkheads)	Subsurface soils	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	UU triaxial (ASTM D2850), CU triaxial (ASTM D4767), moisture content (ASTM D2216), unit weight (ASTM D7263), Atterberg limit (ASTM D4318), grain size (ASTM D422), USCS classification (ASTM D2487)	N/A	One boring to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions. Soils samples selected for testing TBD by the Engineer after boring completion.	ASTM D2850, ASTM D4767, ASTM D2216, ASTM D7263, ASTM D4318, ASTM D422, ASTM D2487	“Shallow” borings needed as part of the bulkhead foundation investigation, to determine the bottom of fill materials, and to characterize soils behind the bulkheads

QAPP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (identify field dups)	Sampling SOP Reference[1]	Rationale for Sampling Location
Geotechnical investigation "deep" borings performed upland of bulkheads, approximately 50 ft from bulkhead edge (at select bulkheads TBD)	Subsurface soils	70 ft investigation depth.	UU triaxial (ASTM D2850), CU triaxial (ASTM D4767), moisture content (ASTM D2216), unit weight (ASTM D7263), Atterberg limit (ASTM D4318), grain size (ASTM D422), USCS classification (ASTM D2487)	N/A	One boring to be performed approximately per 400 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions. Soils samples selected for testing TBD by the Engineer after boring completion.	ASTM D2850, ASTM D4767, ASTM D2216, ASTM D7263, ASTM D4318, ASTM D422, ASTM D2487	CPTs needed for bulkhead replacement/repair design
Geotechnical investigation CPTs performed upland of bulkheads, approximately 50 ft from bulkhead edge (at select bulkheads TBD)	Subsurface soils	70 ft investigation depth.	CPT sounding (ASTM D5778)	N/A	One CPT to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions.	ASTM D5778	Bulkhead foundation investigation CPT needed as part of the bulkhead foundation investigation testing

CPT = cone penetrometer test
CU = consolidated undrained
ft = feet
N/A = not applicable
NAPL = non-aqueous phase liquid
SOP = standard operating procedure
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
USCS = United Soil Classification System
UU = unconsolidated undrained
VOC = volatile organic compound

[1]Specify the appropriate letter or number from the Project Sampling SOP References table (WS#21).

QAPP Worksheet #19 – Analytical SOP Requirements Table

Analytical SOP Requirements listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Analytical Group	Analytical and Preparation Method [(1)]	Sample Volume/Mass per Analysis	Containers (number, size, and type)	Preservation Requirements (chemical, Temperature, light protected) [(2)]	Maximum Holding Time (preparation/ analysis)
Water	TCL VOCs	EPA SW846 8260B/8260C	40 mLs	(3) 40-mL VOA glass vials(with Teflon lined septum)	Cool to $\leq 6^{o}C$, pH <2, HCL, No headspace	14 days
Water	TCL SVOCs	EPA SW846 8270C	1 liter	(2) 1 L amber glass	Cool to $\leq 6^{o}C$	7 days to extraction; 40 days to analysis
Water	TAL Metals	EPA SW846 6010C/6020A	50 mLs	250 mL polyethylene	Cool to $\leq 6^{o}C$, pH <2 HNO3	6 months
Water	Mercury	EPA SW846 7470A	50 mls	250 mL polyethylene	Cool to $\leq 6^{o}C$, pH <2 HNO3	28 days

HCl = hydrochloric acid
HNO_3 = nitric acid
mL = milliliter
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TCL = Target Compounds List
VOA = Volatile Organic Analysis
VOC = volatile organic compound

(1) Analytical and preparation method SOP references provided in Worksheet #23.
(2) The sample containers used for each chemical parameter must be certified as clean or decontaminated by the laboratory. All coolers must contain a temperature blank to verify that temperature preservation requirements are being met.

QAPP Worksheet #20 – Field Quality Control Sample Summary Table

Field Quality Control Samples listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations[2]	No. of Field Duplicate Pairs	No. of MS/MSD	No. of Field Blanks	No. of Equip. Blanks	No. of Trip Blanks	Total No. of Samples to Lab
Water	TCL VOCs	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples	TBD	TBD	1 per cooler	TBD
Water	TCL SVOCs	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples.	TBD	TBD	N/A	TBD
Water	TAL Metals	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples	TBD	TBD	N/A	TBD
Water	Mercury	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples	TBD	TBD	N/A	TBD

MS/MSD = matrix spike/matrix spike duplicate
N/A = not applicable
QC = quality control
SOP = standard operating procedure
SVOCs = semi-volatile organic compounds
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
VOCs = volatile organic compounds

[1]Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

[2]If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location or station.

QAPP Worksheet #21 – Project Sampling SOP References Table

Reference Number	Title, Revision Date and / or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
TBD	Monitoring Well Construction and Development	TBD	Refer to SOP	N	N/A
TBD	Collection of Groundwater Samples	TBD	Refer to SOP	N	N/A
TBD	Operation of Multiparameter Water Sonde	TBD	Refer to SOP	N	N/A
TBD	Manual Collection of Surface Water Samples	TBD	Refer to SOP	N	N/A
TBD	Sediment Sampling	TBD	Refer to SOP	N	N/A
TBD	Recording Station Location Position with a GPS	TBD	Refer to SOP	N	N/A
TBD	Decontamination Procedure for Sampling Equipment	TBD	Refer to SOP	N	N/A
TBD	Field Documentation, Sample Designation, Custody and Handling Procedures	TBD	Refer to SOP	N	N/A
TBD	Procedure to Prepare Samples for Shipment	TBD	Refer to SOP	N	N/A
TBD	Management and Disposal of Investigation Derived Waste	TBD	Refer to SOP	N	N/A
TBD	Air Monitoring	TBD	Refer to SOP	N	N/A
TBD	Procedure to Conduct a Technical System Field Audit	TBD	Refer to SOP	N	N/A
TBD	All other applicable field SOPs	TBD	Refer to SOP	N	N/A

N/A = not applicable
SOP = standard operating procedure
TBD = to be determined

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection Table

THERMOMETER
Parameters: Thermometers will be used to measure temperatures inside sample storage refrigerators and freezers. Thermometers will measure temperature in degrees Celsius (ºC). The thermometer will be used to ensure environmental samples are held at ≤6 ºC (refrigerators) or below 0 ºC (freezers).
Calibration: Thermometers used for the BCSA RI/FS will be certified calibrated from the manufacturer. Refrigerator thermometers will be capable of measuring temperatures to the nearest 1 ºC for a minimum range of negative 2 to 10 ºC. Freezer thermometers will be capable of measuring temperatures to the nearest 1 ºC for a minimum range of negative 25 to negative 5 ºC. Thermometers must be rated for continuous operation at temperatures of less than 0 ºC.
Maintenance: All maintenance activities should be appropriately documented in a logbook that is dedicated to maintenance for this instrument type (i.e., multiple instruments of the same type can be logged in one logbook).
Testing: Accuracy of thermometers may be tested using a second certified calibrated thermometer to verify temperature readings. Testing results should be recorded as appropriate.
Inspection: Thermometers should be inspected for signs of damage.
Frequency: Thermometers should be inspected prior to storage of environmental samples in field office refrigerators or freezers. Maintenance and inspection results should be recorded and stored in the field office.
Acceptance: During testing, certified thermometers should display readings within 1 ºC of each other. Refrigerators should be maintained at temperatures of ≤6 ºC. Freezers should be maintained at temperatures below 0 ºC.
Corrective Action: If thermometers do not meet acceptance criteria they should be replaced.
Responsible Person: Field Team Leader
SOP Reference: NA

REFRIGERATORS/FREEZERS
Application: Refrigerators/freezers are used for temporary storage of project environmental samples. Food and beverages will not be stored in refrigerators/freezers where environmental samples are stored.
Maintenance: Sample storage refrigerators will be maintained in a clean condition. The temperature of the refrigerator will be adjusted to 4 ºC and the temperature of freezers will be less than 0 ºC.
Acceptance: During testing, refrigerators should be ≤6 ºC and freezers should be less than 0 ºC, as monitored by a certified thermometer. Monitoring is performed daily when samples are being stored.
Corrective Action: Refrigerators will be cleaned prior to storage of environmental samples.
Responsible Person: Field Team Leader
SOP Reference: NA

SIDE SCAN SONAR INSTRUMENTATION
Application: Instrumentation will be used to identify debris in the Canal. Specific instrumentation has not yet been selected.
Maintenance: TBD
Acceptance: TBD
Corrective Action: TBD
Responsible Person: TBD
SOP Reference: TBD

GROUNDWATER UPWELLING INSTRUMENTATION
Application: Instrumentation will be used to identify location of groundwater upwelling and to quantify discharge rates. Specific instrumentation has not yet been selected.
Maintenance: TBD
Acceptance: TBD
Corrective Action: TBD
Responsible Person: TBD
SOP Reference: TBD

FILED BASED NAPL DISTRIBUTION ASSESSMENT INSTRUMENTATION
Application: TarGOST ® or similar instrumentation will be used to assess NAPL distribution in the field. Specific technology will be selected during the desktop study.
Maintenance: TBD
Acceptance: TBD
Corrective Action: TBD
Responsible Person: TBD
SOP Reference: TBD

ºC = degrees Celsius
NAPL = non-aqueous phase liquid
TBD = to be determined

QAPP Worksheet #23 – Analytical SOP References Table

Analytical SOP References listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
TBD	TBD	Definitive	TCL VOCs/water	GC/MS	TBD	N
TBD	TBD	Definitive	TCL SVOCs/water	GC/MS	TBD	N
TBD	TBD	Definitive	TAL Metals/water	ICP/MS	TBD	N
TBD	TBD	Definitive	TAL Metals/water	ICP	TBD	N
TBD	TBD	Definitive	Mercury/water	CVAA	TBD	N

CVAA = cold vapor atomic absorption
GC/MS = gas chromatography–mass spectrometry
ICP/MS = inductively coupled plasma mass spectrometry
SOP = standard operating procedure
SVOC = semi-volatile organic compound
TBD = to be determined
TAL = Target Analyte List
TCL = Target Compounds List
VOC = volatile organic compound

QAPP Worksheet #24 – Analytical Instrument Calibration Table

Analytical instrumentation calibration information listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD
ICP/MS	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD
GC/MS	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD
CVAA	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD

CA = corrective action
CVAA = cold vapor atomic absorption
GC/MS = gas chromatography mass spectrometry
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma mass spectrometry
SOP = standard operating procedure
TBD = to be determined

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Analytical instrument and equipment maintenance, testing, and inspection information listed below applies only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS	• Clean sources, maintain vacuum pumps	Tuning	Instrument performance and sensitivity	Service vacuum pumps twice per year, other maintenance as needed	Tune and CCV pass criteria	Recalibrate instrument	Laboratory Chemist	TBD
GC/MS	• Change septum, clean injection port, change or clip column, install new liner, change trap	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	Tune and CCV pass criteria	Re-inspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Laboratory Chemist	TBD
ICP	• Increase rinse time • Clean or replace tip • Clean or replace torch • Clean or replace sample tubing • Clean or replace nebulizer • Clean or replace mixing chamber	Normal analysis	High blanks are noticed	As needed	Acceptable Calibration Check	Clean and replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP	• RF not cooling properly • Replace torch (Crack) • Clean or replace nebulizer (blockage) • Check room temperature (changing) • Replace pump tubing • Room humidity too high • Clean torch tip (salt buildup) • Check for argon leaks • Adjust sample carrier gas • Replace PA tube	Initial and continuing calibration	Instrument Drift is noted	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD
ICP	• Check for argon leaks • Adjust sample carrier gas • Replace tubing (clogged) • Check drainage(back pressure changing) • Increase uptake time (too short) • Increase flush time (too short) • Clean nebulizer, torch or spray chamber • Increase sample volume introduced • Check that autosampler tubes are full • Sample or dilution of sample not mixed • Increase integration time (too short) • Realign torch • Reduce amount of tubing	Normal analysis	Erratic Readings, Flickering Torch or High RSD	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
	connectors							
ICP/MS	• Increase rinse time • Clean or replace tip • Clean or replace torch • Clean or replace sample tubing • Clean or replace nebulizer • Clean or replace mixing chamber	Normal analysis	High blanks are noticed	As needed	Acceptable Calibration Check	Clean and replace parts	Laboratory Chemist	TBD
ICP/MS	• RF not cooling properly • Replace torch (Crack) • Clean or replace nebulizer (blockage) • Check room temperature (changing) • Replace pump tubing • Room humidity too high • Clean torch tip (salt buildup) • Check for argon leaks • Adjust sample carrier gas • Replace PA tube	Initial and continuing calibration	Instrument Drift is noted	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP/MS	• Check for argon leaks • Adjust sample carrier gas • Replace tubing (clogged) • Check drainage(back pressure changing) • Increase uptake time (too short) • Increase flush time (too short) • Clean nebulizer, torch or spray chamber • Increase sample volume introduced • Check that autosampler tubes are full • Sample or dilution of sample not mixed • Increase integration time (too short) • Realign torch • Reduce amount of tubing connectors	Normal analysis	Erratic Readings, Flickering Torch or High RSD	As needed	None	Clean and/or replace parts	Laboratory Chemist	TBD
ICP/MS	• Remove and Clean Cones	Normal analysis	Erratic Readings, Flickering Torch or High RSD	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
CVAA	• Check burn head	Calibration and calibration checks	Erratic readings	Daily	Calibration check standards pass	Clean or replace	Laboratory Chemist	TBD
CVAA	• Check Nebulizer	Calibration and calibration checks	Erratic readings	Weekly	Calibration check standards pass	Clean or replace	Laboratory Chemist	TBD
CVAA	• Check for leaks	Calibration and continuing calibration checks	Erratic readings	As needed	Calibration check standards pass	Replace Tygon Tubing	Laboratory Chemist	TBD

CCV = continuing calibration verification
CVAA = cold vapor atomic absorption
GC/MS = gas chromatography mass spectrometry
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma mass spectrometry
RF = response factor
RSD = relative standard deviation
SOP = standard operating procedure
TBD = to be determined

QAPP Worksheet #26 – Sample Handling System

Sample Collection, Packaging, and Shipment
Sample Collection (Personnel/Organization): Field Team Leader, TBD
Sample Packaging (Personnel/Organization): Field Team Leader, TBD
Coordination of Shipment (Personnel/Organization): Field Team Leader, TBD
Type of Shipment/Carrier: Courier and overnight shipping: Commercial Courier
Sample Receipt and Analysis
Sample Receipt (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Custody and Storage (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Preparation (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Determinative Analysis (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Archiving
Sample Extract/Digestate Storage (Number of days from extraction/digestion): Sample extracts (as applicable) will be stored in the lab for 30 days unless notified by the client to archive for a longer period of time
Biological Sample Storage (No. of days from sample collection): TBD as applicable
Sample Disposal
Personnel/Organization: Sample Receiving Personnel, Sample Receiving Personnel, Laboratory TBD
Number of Days from Analysis: Field Samples are stored for 30 days after submittal of the completed data package.

TBD = to be determined

QAPP Worksheet #27 – Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

The following procedures will be implemented when samples collected during this project are shipped:

- Confirm that sample labels are securely affixed to sample containers.
- Check the caps on the sample containers to confirm that they are properly sealed.

Complete the chain of custody form with the required sampling information and confirm that the recorded information matches the sample labels. The appropriate personnel will sign and date the chain of custody form to document the sample custody transfer.

- Wrap sample containers in bubble wrap or other cushioning material.
- Place cushioning material at the bottom of the cooler.
- Place the sealed sample containers and a temperature blank in the cooler.
- Place a sufficient amount of wet ice in the cooler to maintain a sample temperature of $\leq$6°C.
- Fill the remaining space in the cooler with cushioning material.
- Place chain of custody forms in plastic bags and seal. Tape the forms to the inside of the appropriate cooler lid.
- Close the cooler lid and secure with tape.
- Wrap tape around both ends of the cooler and attach Custody Seals to cooler and cover with clear protective tape.

Mark the cooler on the outside with the following information: shipping address, return address, “Fragile” labels, and arrows indicating “this side up.” Place a signed custody seal over the cooler lid.

The coolers will be delivered to the laboratory (to be determined). Coolers will be marked to indicate refrigeration is needed and placed in a cooler at the cargo facility if held overnight before receipt from the project laboratory. Multiple coolers may be sent in one shipment to the laboratory.

Laboratory Sample Custody Procedures (receipt of samples, archiving, and disposal):

Laboratory chain of custody begins when samples are received and continues until samples are discarded. The laboratory should designate a specific individual as the sample custodian. The custodian will receive all incoming samples, sign the accompanying custody forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record all pertinent information concerning the samples, including the persons delivering the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample identification numbers, and any unique laboratory identification numbers for the samples. This information should be entered into a computerized laboratory information management system (LIMS). When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for all samples. Access to this area will be restricted to authorized personnel. The custodian will confirm that samples requiring special handling, including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics, will be properly stored and maintained prior to analysis. Laboratory standard operating procedures for sample custody, tracking, archiving and disposal are located at the laboratory and the Consultant project office and will be available upon request.

Sample Identification Procedures:

A unique sample identification number will be assigned to each sample collected during this project. The sample numbering system allows each sample to be uniquely identified and provides a means of tracking the sample from collection through analysis. A distinction is made between the actual physical location of sampling (point identification) and the various methods of collecting the sample.

Below is an example of a unique numbering scheme that consists of a combination of Site and sampling activity information, as follows:

Sample Location Identifier

- Type of sample, to be determined during task development
    - e.g. WWC to indicate waterway core

Sample location at each Site

- Four digit sample location code (e.g. 1000)

Depth Interval (if applicable)

- Depth below ground surface (centimeters [cm])
    - Shallow interval listed first (dash) deep interval listed second
    - e.g. 2-4 would indicate 2cm below ground surface to 4 cm below ground surface.

Sample Matrix

- WS – Surface Water
- WP – porewater
- WG – Groundwater
- LN - NAPL
- SE – Sediment
- SO – Soil
- TA – biota – will also require a species designation (e.g., TA-Crab-…)
- AA – air monitoring
- IDW – investigation derived waste
- Note that sample matrix codes are compliant with the EPA Region 2 Electronic Data Deliverables (EDD) Valid Values list

Sampling Event (Date as YYMMDD)

- August 15, 2014 would be: 140815

An example of identification of a sample collected from ….:

- WWC-1000-2-4-SD-140815

Sample Labels

A sample label will be affixed to all sample containers appropriate for the Site and sample location. The label will be completed with the following information:

- Project name;
- Sample identification number;
- Date and time of sample collection;
- Sample matrix (e.g., sediment, soil);
- Preservative used (if applicable);
- Sample collector's initials; and
- Analysis required.

Sample Documentation

Documentation during sampling is essential to confirm proper sample identification. Field personnel will adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout.
- Any serialized documents will be maintained in the project file and referenced in the Site logbook.
- Unused portions of pages will be crossed out, and each page will be signed and dated.

Chain-of-Custody Procedures:

Field sample personnel will use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample will be considered to be in custody if one of the following statements applies.

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal so that the sample cannot be reached without breaking the seal.

Chain of custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The chain of custody record will also be used to document all samples collected and the analyses requested. Information that the field personnel will record on the chain of custody record includes:

- Project name and number;
- Sampling location;
- Name and signature of sampler;
- Destination of samples (laboratory name);
- Sample identification number;
- Date and time of collection;
- Number and type of containers filled;
- Analysis requested;
- Preservatives used (if applicable);
- Filtering (if applicable);
- Sample designation (grab or composite);
- Signatures of individuals involved in custody transfer, including the date and time of transfer; and
- Project contact and phone number.

Field personnel will sign chain of custody records that are initiated in the field, and the air bill number will be recorded. The record will be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed air bills will serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the chain of custody record and the air bill will be retained and filed by field personnel before the containers are shipped.

QAPP Worksheet #28 – QC Samples Table

QC Samples listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method blank	1 per batch of 20 or fewer samples	< ½ RL. If the analyte is a common laboratory contaminant (i.e., methylene chloride, acetone, 2-butanone, ethyl ether, acetonitrile and hexane), the data may be reported with qualifiers if the concentration of the analyte is less than the RL.	If the analyte is a common laboratory contaminant, the data may be reported with qualifiers if the concentration of the analyte is less than the RL. Such action must be taken in consultation with the client. Reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the associated samples. If there is no target analyte greater than the ½ the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be done in consultation with the client. If surrogate recoveries in the blank are not acceptable, the data must be evaluated to determine if the method blank has served the purpose of demonstrating that the analysis is free of contamination. If surrogate recoveries are low and there are reportable analytes in the associated	Analyst	Sensitivity	< ½ RL. If the analyte is a common laboratory contaminant (i.e., methylene chloride, acetone, 2-butanone, ethyl ether, acetonitrile and hexane), the data may be reported with qualifiers if the concentration of the analyte is less than the RL.

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			samples, re-extraction of the blank and affected samples will normally be required. Consultation with the client should take place. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all affected analytes in the associated samples are flagged with a "B," and appropriate comments may be made in a narrative to provide further documentation.			
Laboratory Control Sample /Laboratory Control Sample Duplicate (LCS/LCSD)	1 LCS per batch of 20 or fewer samples. Analyze an LCSD if an MS/MSD is not analyzed	%R and RPD within laboratory control limits	If any analyte or surrogate is outside established control limits, the system is out of control and corrective action must occur. Corrective action will normally be re-preparation and reanalysis of the batch. If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records (via NCMs and the case narrative) and in the final report. Examples of acceptable reasons for not reanalyzing might be that the MS and MSD are acceptable, and sample surrogate	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			recoveries are good, demonstrating that the problem was confined to the LCS. This type of justification should be reviewed and documented with the client before reporting. If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a report narrative.			
MS/MSD	1 pair batch of 20 or fewer samples	%R and RPD within laboratory control limits	The initial corrective action will be to check the recovery of that analyte in the LCS. Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed. The reasons for accepting the batch must be documented. If the recovery for any component is outside QC limits for both the MS/MSD and the LCS, the analysis is out of control and corrective action must be taken. Corrective action will normally include reanalysis of the batch, except in cases	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			where a high bias is indicated and no target is detected above the RL in any associated sample. If an MS/MSD is not possible due to limited sample, then a LCSD should be analyzed. The RPD between the LCS and LCSD are compared to the established acceptance limit.			
Surrogates		Within laboratory historical limits	Check all calculations for error, ensure that instrument performance is acceptable, recalculate the data and/or reanalyze if either of the above checks reveal a problem, re-prepare and reanalyze the sample or flag the data as "Estimated Concentration" if neither of the above resolves the problem. The decision to reanalyze or flag the data should be made in consultation with the client. It is necessary to re-prepare/ reanalyze a sample only once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out of control results are not due to matrix effect. If the surrogates are out of control for the sample, MS/MSD,	Analyst	Accuracy	Within laboratory historical limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			then matrix effect has been demonstrated for that sample and re-preparation/reanalysis is not necessary. If the sample is out of control and the MS and/or MSD is in control, then reanalysis or flagging of the data is required. Re-analysis is not necessary if obvious matrix effect is shown in the chromatograms or were noted in sample prep. A NCM is generated stating the reason for not re-analyzing the affected sample.			

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL SVOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8270C/SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Method blank	1 per batch of 20 or fewer samples	< RL or < 10% of the concentration found in the associated samples	Re-preparation and reanalysis of all associated samples. If the analyte was not detected in the samples, the data may be reported with qualifiers and it must be addressed in the project narrative.	Analyst	Sensitivity	< RL or < 10% of the concentration found in the associated samples
LCS/LCSD	1 LCS per batch of 20 or fewer samples. Analyze an LCSD if an MS/MSD is not analyzed	%R and RPD within laboratory control limits	If the LCS recovery is high and there are non-detect samples. An NCM is initiated. If data is to be reported, it must be authorized by the client via a variance on a site by site basis. If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. If re-extraction and reanalysis of the batch are not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative.	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits
MS/MSD	1 pair batch of 20 or fewer samples	%R and RPD within laboratory control limits	If the recovery for any analyte fails acceptance criteria for the MS, MSD, and the LCS, corrective action will normally include re-preparation and reanalysis of the batch. If it is not	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL SVOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8270C/SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			possible to prepare both an MS and MSD due to limitations of sample amount, then a duplicate LCS should be prepared and analyzed. The RPD between the LCS and LCSD must be less than or equal to the RPD limit established for the MS/MSD.			
Surrogates		Within laboratory historical limits	Check all calculations for error. Ensure that instrument performance is acceptable. Recalculate the data and/or reanalyze the extract if either of the above checks reveals a problem. Re-extract and reanalyze the sample or flag the data as "Estimated Concentration" if neither of the above resolves the problem.	Analyst	Accuracy	Within laboratory historical limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**Mercury**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 7470A SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Laboratory Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method blank	One method blank must be processed with each preparation batch of up to 20 samples.	The method blank should not contain any analyte of interest at or above the RL or above 10% of either the measured concentration of that analyte in associated samples or the regulatory limit.	Re-preparation and reanalysis of all samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples (see exception noted above). If there is no analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action must be taken in consultation with the client and must be addressed in the project narrative. If the above criteria are not met and reanalysis is not possible, then the sample data must be qualified. This anomaly must be addressed in the project narrative and the client must be notified.	Laboratory Analyst	Sensitivity	Same as Method / SOP QC Acceptance Limits
Laboratory control sample (LCS)	One LCS must be processed with each preparation batch of up to 20 samples.	In-house control limits are 80 - 120%	In the instance where the LCS recovery is > 120% and the sample results are < RL, the data may be reported with qualifiers. Such action must be taken in consultation with the client and must be addressed in the case narrative. Corrective action will be re-preparation and reanalysis of the batch unless the client agrees that other corrective action		Accuracy	

			is acceptable.			
MS/MSD	One MS/MSD pair must be processed for each preparation batch of up to 20 samples.	Until in-house control limits are established, a control limit of 75-125 % recovery & 20% RPD must be applied to the MS/MSD.	If analyte recovery or RPD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS. If the LCS recovery is within limits, then the laboratory operation is in control and the results may be accepted. If the recovery of the LCS is outside limits, corrective action must be taken. Corrective action will include re-preparation and reanalysis of the batch. MS/MSD results which fall outside the control limits must be addressed in the narrative. If the native analyte concentration in the MS/MSD exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated). If the reporting software does not have the ability to report NC then the actual recovery must be reported and narrated as follows: "Results outside of limits do not necessarily reflect poor method performance in the matrix due to high analyte concentrations in the sample relative to the spike level."		Accuracy	

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Method blank	One method blank must be processed with each batch of 20 or fewer samples.	The method blank must not contain any analyte of interest at or above the reporting limit (except common laboratory contaminants, (copper, iron, zinc), or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.	If the analyte is a common laboratory contaminant (copper, iron, zinc), the data may be reported with qualifiers if the concentration of the analyte in the method blank is less than five times the RL. Such action must be documented in the NCM program. Re-preparation and reanalysis of any samples with reportable concentrations of analytes less than 10 times the value found in the method blank is required unless other actions are agreed with the client. If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported. This must be documented in the NCM program. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all positive results in associated samples are flagged with a "J," and appropriate comments may be made in a narrative to provide further documentation.	Laboratory Analyst	Sensitivity	Same as Method / SOP QC Acceptance Limits
Laboratory	LCS is	All analytes must be within	If any analyte in the LCS is outside the		Accuracy	

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Control Samples (LCS)	prepared and analyzed with every batch of 20 or fewer samples	laboratory established historical control limits.	laboratory established historical control limits, corrective action must occur: Check calculations, check instrument performance, reanalyze the LCS, and if still outside of control limits, evaluate the data, and/or re-prepare and reanalyze all samples in the QC batch. Data may be reported with an anomaly in the following cases: The LCS recoveries are high and the analyte of concern is not detected in field samples, all target requested analytes are within control, but other LCS compounds are out of control, if no sample preparation is performed (e.g., dissolved metals), the LCS may be re-prepared and reanalyzed within the same sequence. The analyst should evaluate the anomalous analyte recovery for possible trends. If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all			

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
			associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.			
MS/MSD	MS/MSD is prepared and analyzed with every batch of 20 or fewer samples	The percent recovery and RPD within the historically generated limits.	If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action will be to check the recovery of that analyte in LCS. Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed. The reasons for accepting the batch must be documented. If the recovery for any component is outside QC limits for both the MS/MSD and the LCS, the process is out of control and corrective action must be taken. Corrective action will normally include re-preparation and reanalysis of the batch. If the amount of an analyte found in the unspiked sample is greater than 4 times the amount of spiked analyte added, then routine control limits do not apply and recoveries are not evaluated.		Accuracy and precision	
Post digestion	One every 20	The spike recovery from	If a result is outside the required range,		Accuracy	

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
spike	samples	the post digestion spiked sample should be within the range 75-125% where the spike value is greater than 25% of the indigenous analyte concentration.	the data should be assessed carefully and samples may require reanalysis.			
Serial dilution	One every 20 samples	The results of the serial dilution sample after dilution correction should be within the range 90-110% of the original sample, if the result for the original sample is greater than 50 times the MDL.	If a result is outside the required range, the data should be assessed carefully and samples may require reanalysis.		Accuracy	
Duplicate sample (DUP)	One every 20 samples	Results of the DUP must be within ±20% RPD of the results of the original sample, where the result is greater than or equal to 5 times the RL.	If a result is outside the required range, the data should be assessed carefully and samples affected may need to be reanalyzed where the project requires it.		Precision	

%R = percent recovery
LCS/LCSD = laboratory control sample/laboratory control sample duplicate
NCM = nonconformance memo
QC = quality control
RL = reporting limit

RPD = relative percent difference
SOP = standard operating procedures
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
VOC = volatile organic compound

QAPP Worksheet #29 – Project Documents and Records Table

Document	Where Maintained
Field Records: Field logbooks, chain of custody records/forms, QAPP deviations, communications and reports, photographs, GPS printouts	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.
Laboratory Analytical Records: Raw and summary data, chain of custody and sample receipt forms, sample and instrument logs	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.
Data Assessment and QA Records: Data validation report, independent technical review forms, CA communications and reports	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.
Reports: Drafts, final reports, communications of progress and deviations	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.

Documents and Records

Documentation is critical for evaluating the success of any environmental data collection activity. The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. This worksheet also lists documents and reports that will be generated as a result of this project.

Field Documentation

Complete and accurate documentation is essential to demonstrate that field measurement and sampling procedures are carried out as described in the QAPP. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the Site name, and the names of subcontractors, the service client, and the Project Manager. At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of all onsite personnel or visitors;
- Weather conditions during the field activity;
- Summary of daily activities and significant events;
- Notes of conversations with coordinating officials;
- References to other field logbooks or forms that contain specific information;
- Discussions of problems encountered and the resolution;
- Discussions of deviations from the QAPP or other governing documents; and
- Description of all photographs taken.

If significant changes to the sampling program are needed because of unanticipated Site conditions, the QAPP will need to be amended and submitted to the EPA Region 2 for review and approval. If the changes are not significant (e.g., a sample or boring location is moved a few feet from the planned location, or additional samples are collected that were not specified in the QAPP), the EPA Region 2 will be notified in the weekly activity report. The field logbook will provide documentation of the deviation from the QAPP with a brief rationale.

Laboratory Documentation and Data Packages

The analytical laboratories that are performing analyses will provide full data packages, which contain all information required for validation. All data packages must contain any of the following elements that are applicable to the analysis to enable validation:

- Title page;
- Table of contents;
- Data package narrative;
- Final data report tables;
- Analytical records:
  - Instrument tuning (GC/MS methods);
  - Degradation control (only for pesticide analyses);
  - Retention Times (RTs) and RT windows for GC/ECD analyses (level 4 validation samples only);
  - Calibration data;
  - Calibration verifications;
  - Surrogate recoveries (GC/MS and GC methods);
  - Internal standard RT checks and area counts for GC/MS analyses (Level 3 and Level 4 validation samples);
  - All QC data required by the analytical method or the QAPP (blanks, LCS/LCSD, MS/ MSD, and duplicates);
  - Chromatograms for GC/ECD and GC/MS samples, calibrations, and QC samples (Level 4 validation samples and associated calibrations and QC samples);
  - Mass spectra for GC/MS analyses regardless of hits or non-detects samples (Level 4 validation samples and associated calibrations and QC samples);
  - Required supporting information;
  - Entire package of sample custody documentation, including sample receipt forms;
  - Sample processing and spiking records;
  - Copies of standard preparation logs for each standard used in sample preparation and instrument calibration;
  - Run logs;
  - Raw data associated with field and QC data;
  - Chromatograms;
  - Sources of control limits for surrogates and LCS; and
  - Source of LCS.
- Description of manual integration procedures; and
- List of current method detection limits for the preparation and analysis methods used for sample processing.

Data Package Format

The subcontracted laboratory will provide electronic data deliverables (EDDs) for all analytical results. An automated LIMS must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. EDDs will be delivered in the EPA Region 2 format. Results that should be included in all EDDs are as follows:

- Target analyte results for each sample and associated analytical methods requested on the chain of custody form;
- Method and instrument blanks and preparation and calibration blank results reported for the sample delivery group (SDG);

- Percent recoveries for the spike compounds in the MS, MSDs, blank spikes, or LCSs;
- Matrix duplicate results reported for the SDG; and
- All re-analysis, re-extractions, or dilutions reported for the SDG, including those associated with samples and the specified laboratory QC samples.

Electronic and hard-copy data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted.

Reports Generated

A Final Report compiling all of the results will be submitted to EPA Region 2 upon completion of the Project Tasks.

EDD = electronic data deliverable
GC = gas chromatography
GC/ECD = gas chromatography electron capture detector
GC/MS = gas chromatography mass spectrometry
GPS = global positioning system
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
MS = matrix spike
MSD = matrix spike duplicate
QA = quality assurance
QC = quality control
RT = retention time
SDG = sample delivery group

QAPP Worksheet #30 – Analytical Services Table

Analytical services listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Number	Analytical SOP	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory / Organization (name and address, contact person and telephone number)
Water	TCL VOCs	Low	See WS#18	TBD	Standard	TBD	TBD
	TCL SVOC	Low					
	TAL Metals	Low/Medium					
	Mercury	Medium					

NAPL = non-aqueous phase liquid
PDWP = Pre-Design Work Plan
SVOCs = semi-volatile organic compounds
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
VOCs = volatile organic compounds
WS = worksheet

QAPP Worksheet #31 – Planned Project Assessments Table

Identify the type, frequency, and responsible parties of planned assessment activities that will be performed for the project.

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (title and organizational affiliation)
Field Safety Audit	At project start up. Periodically during field activity. Daily tailgate safety meeting.	Internal	TBD	Task Field PM SSHO	Task PM	Task PM Task Field PM	Task PM Task Field PM SSHO
Technical System Internal Inspections of Field Sampling Procedures	Daily during Field Sampling Activities	Internal	TBD	Task Field PM	Task PM	Task PM Task Field PM	Task PM Task Field PM
Offsite Laboratory Technical Systems Audit	Per Laboratory QA Manual	Internal	Laboratory	Per Laboratory QA Manual	Per Laboratory QA Manual	Laboratory Personnel	Per Laboratory QA Manual
Data Quality Assessment	Upon receipt of analytical data packages	Internal	TBD	QA Manager	Laboratory PM	Laboratory PM	QA Manager

PM = Project Manager
QA = quality assurance
SSHO = Site Safety and Health Officer

QAPP Worksheet #32– Assessment Findings and Corrective Action Responses

For each type of assessment describe procedures for handling QAPP and project deviations encountered during the planned project assessments.

Assessment Type	**Nature of Deficiencies Documentation**	**Individual(s) Notified of Findings** (name, title, organization)	**Timeframe of Notification**	**Nature of Corrective Action Response Documentation**	**Individual(s) Receiving Corrective Action Response** (name, title, organization)	**Timeframe for Response**
Field Safety Audit	Audit Report	Task PM Team PM National Grid PM	Within one week of audit	Memo	Task Field PM SSHO	Within one week of receiving the audit report
Technical System Internal Audit of Field Sampling Procedures	Audit Report	Task PM	Within two weeks of audit	Memo	Task PM Task Field PM	Within one week of receiving the audit report
Offsite Laboratory Technical Systems Audit	Internal Audit Report	Laboratory Manager/ Laboratory Technical Director/ Laboratory Operations Manager	Annual audit	Per Individual Laboratory QA Manual	QA Manager	Per Individual laboratory QA Manual
Data Quality Assessment	Data Quality Assessment Report (DQAR)	QA Manager	Upon receipt of analytical data package	Non-conformance memos	QA Manager	Within two weeks of issuance of DQAR

DQAR = Data Quality Assessment Report
PM = Project Manager
QA = quality assurance
SSHO = Site Safety and Health Officer

1.0 ASSESSMENT

This worksheet addresses assessment of the effectiveness of the project implementation and the associated QA/QC activities.

1.1. Field Assessment and Response Actions

To monitor the capability and performance of the field activities, field inspections will be performed as follows. QC is the means by which compliance with contract requirements is ensured. QC practices will cover both onsite and offsite activities that are relevant to the project.

The Field PM will inspect all work activities to ensure that they are performed in accordance with plans and specifications. The Field PM will prepare weekly activity reports attesting to this fact. Any problems or concerns will be immediately discussed with the EPA Region 2, and the appropriate CA determined and addressed.

1.1.1.1 Equipment Inspections

Inspections will be performed daily on all equipment prior to and during their use to ensure the equipment is in safe operating condition. The Field PM will perform these inspections along with the operator.

All preventative maintenance procedures recommended by the manufacturer will be followed. Any equipment found to be unsafe will be flagged and its use prohibited until unsafe conditions have been corrected.

1.2. Verification and Testing Procedures

1.2.1. Non-conformance/Corrective Action (CA)

Non-conforming items and activities are those that do not meet the project requirements. When such a condition is identified, Consultant will implement a CA program to:

- Document the non-conforming item or procedure and determine the cause of the non-conformance and its effect on project performance and the integrity of completed work;
- Correct or replace the non-conforming item in the most efficient and effective manner; and
- Verify and document that the corrective action taken is successful.

1.2.2. Documentation of Non-Conforming Items

The Field PM will document any non-conformance item in the field logbook and summarize it in the weekly activity report. This list will clearly state what is not complying, the date the noncompliance was originally discovered, and the date the work was corrected.

1.2.3. Implementation of CA

Consultant will stop work on any item or feature pending satisfactory correction of the deficiency noted by the PM or the EPA Region 2 RPM. The PM and Field PM will have the authority to stop work until CAs are implemented. In some cases, the CA may be obvious and may be implemented immediately upon identification of the non-conformance. Others may require additional input from technical and/or operations staff, additional equipment and/or materials, or changes in existing structures or completed work. The PM and Field PM will not allow work to be added to or built upon non-conforming work unless the EPA Region 2 RPM concurs that the correction can be made without disturbing continuing work.

1.2.4. Verification and Documentation of CA

The Field PM will verify successful completion of CAs for non-conformances on a follow-up inspection. The Weekly Activity Report will reflect all CAs completed. The Field PM will also update the re-work item list with the CA taken and the date the CA was completed. Recurring non-conformances of similar nature will be investigated to determine the root cause of the problem so as to eliminate or minimize future occurrences of the non-conformance.

2.0 INTERNAL LABORATORY AUDITS

As part of its QA program the laboratory QA/QC manager will conduct periodic checks and audits of the analytical systems to verify that the systems are working properly and personnel are adhering to established procedures and documentation practices. These checks and audits will also assist in determining or detecting where problems are occurring. In addition to conducting internal reviews and audits, as part of its established QA program, the laboratory is required to take part in regularly scheduled Performance Evaluations and laboratory audits from State and Federal agencies for applicable tests. Each laboratory selected to support this project must maintain current NELAP or Federal certifications and EPA Region 2 approval, as appropriate.

2.1 Verification and Documentation of CA

2.1.1 Non-Conformance/QC Reporting

A non-conformance is defined as an identified or suspected deficiency or discrepancy with regard to an approved document (e.g., improper sampling procedures, improper instrument calibration, calculation, computer program); or an item where the quality of the end product itself or subsequent activities using the document or item would be affected by the deficiency; or an activity that is not conducted in accordance with the established plans or procedures.

Any team member engaged in project work that discovers or suspects a non-conformance is responsible for informing the PM or Field PM. The PM will evaluate each non-conformance and provide a disposition, which describes the actions to be taken.

The PM or Field PM will verify that no further project work that is dependent on the non-conforming item or activity is performed until the situation has been corrected back to the original condition intended by the project documentation. Documentation of the non-conformance and CA, along with the appropriate verification and approval signatures, will be included in the project file. Copies of the non-conformances will be maintained by the PM.

2.1.2 Laboratory CAs

If a particular laboratory analysis is deemed "out of control," CA will be taken by the laboratory to maintain continued data quality.

Each laboratory must adhere to their in-house CA policy. The coordinator of the laboratory's analytical section will be responsible for initiating laboratory CA when necessary.

CA = Corrective Action
NELAP = National Environmental Laboratory Accreditation Program
PM = Project Manager
QA = Quality Assurance
QC = Quality Control
RPM = Remedial Project Manager
SSHO = Site Safety and Health Officer

QAPP Worksheet #33 – QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Field Safety Audit Report	Initial, at project start up, and periodically throughout the duration of field activities	Two weeks after audit	SSHO	Task PM Project PM National Grid PM Project file
Daily Activity Reports	Daily throughout duration of field activities	Daily	Task Field PM	Task PM Project PM Project file
Weekly Activity Reports	Weekly	Beginning of each week	Task Field PM	Task PM Project EM National Grid PM EPA Region 2 RPM Project file
Monthly Status Reports	Monthly	End of each month	Task Field PM	Task PM Project PM National Grid PM EPA Region 2 RPM Project file
Data Validation Reports	On-going upon receipt of data deliverables	Three weeks after receipt of data deliverable	QA Manager	Task PM Project PM EPA Region 2 RPM Project file
Corrective Action Reports	As identified	Immediately upon identification	Team member identifying non-conforming activity or item Team Field PM	Task PM Project PM National Grid PM EPA Region 2 RPM Project file
Final Project Report	At the completion of the assigned project tasks	Per project schedule	Team Field PM	Task PM Project PM National Grid PM National Grid PD EPA Region 2 RPM Project file

QAPP Worksheet #33 – QA Management Reports Table (continued)

Periodic QA Management reports ensure that managers and stakeholders are updated on project status and the results of all QA assessments. Efficient communication of project status and problems allows PMs to implement timely and efficient corrective actions so that the data meets the data quality objectives for the project. EPA Region 2 will receive several types of management reports. These will include the results of any corrective action items and data validation reports. In addition, each report will contain a section on quality control. Problems or issues that arise between regular reporting periods may be identified to program management at any time. Information included in a progress report will include but not be limited to the following:

- Results of technical systems audits conducted during the period.
- An assessment of any problems.
- A listing of the non-conformance reports including Stop-Work Orders issued during the period, related CA undertaken, and an assessment of the results of these actions.
- Identification of significant QA problems and recommended solutions, as necessary.

PM = Project Manager
QA = quality assurance
RPM = Remedial Project Manager
SSHO = Site Safety and Health Officer

QAPP Worksheet #34 – Verification (Step I) Process Table

Verification Input	Description	Internal/External	Responsible for Verification
Planning Documents	QAPP documents will be evaluated prior to implementation. Examples of items for review will include personnel, training, laboratories, methods, SOPs, performance requirements, data quality objectives, forms, QAPPs, location maps, naming conventions, and project specific analytes.	I/E	PM and QA Manager Task Manager Field PM EPA Region 2 RPM Project file
Field Activity Documentation	The Field PM will review all documentation recorded by the field team during all field activities. This will include field log books, field data forms (electronic and paper), calibration records, sampling location plans, decontamination records, and daily reports.	I	Task PM Field PM
Field Data	The data generated in the field to support the project will be checked as completed against the requirements of the QAPP documents, specific data collection requirements and applicable field SOPs. The data will be reviewed by the technical lead(s) prior to being included in the associated task.	I	Task PM Field PM Task Leader (designated during activity)
Chain of Custody Documentation	The Chain of Custody documents will be peer-reviewed in the field prior to shipping of samples. The Chain of Custody will also be reviewed upon receipt by the laboratory personnel and again by the data reviewers and validation team upon receiving the analytical data packages.	I	Field PM Task Leader (designated during activity) QA Manager

QAPP Worksheet #34 – Verification (Step I) Process Table (continued)

Verification Input	Description	Internal/External	Responsible for Verification
Corrective Action (CA) and Non-Conformance documentation	CA and non-conformance reports will be checked as completed with the CA in place.	I	Task PM QA Manager Field PM
Analytical Data Packages	Analytical data results will be checked as completed against the requirements of the QAPP, specific method requirements and laboratory SOPs. Analytical data packages will be reviewed by the laboratory prior to release and by the validation team upon receipt of the data.	E/I	QA Manager
EDDs	The EDDs will be developed and provided by the laboratories. EDDs will be text files and include, at a minimum, all required data fields described in the EPA Region 2 EDD requirements. Concentration and detection limit data will be delivered as string (as opposed to numeric) field types to ensure that the precision (i.e., number of significant digits) intended by the laboratory is represented in the EDDs. EDDs will be reviewed by the laboratory prior to release of the data and by data management and the validation team upon receipt.	I	Task PM QA Manager
QC Summary Report	A summary of all laboratory QC sample results will be verified for completeness by the QA team upon receipt of data packages from the laboratory.	I	QA PM Field Leader
Data Handling	The following operations will be evaluated for completeness and accuracy: electronic or manual data transfer, entry, use, and reporting of data for computer models, algorithms, and data bases; correlation studies between variables, and data plotting.	I	Task PM QA Manager

Data Verification

During the data verification process, the laboratory data will be reviewed for each analytical test to evaluate the completeness of the data set to each reference method and/or to the project requirements. This review will include all of the data received from the laboratory. Depending on the level of receivables, these records should include the sample preparation procedure, instrument calibration data and continuing calibration data, QC sample results, sample identification, chains of custody, and indicate holding times. These records should also include the completion of all records to identify the analyst(s) who performed the testing and the dates and times of sample preparation and analysis. Each type of calculation will be reviewed as to its completeness. It is the job of the data qualifier to thoroughly review the data package and to record any deviations that may have occurred.

Data Review Process (Steps I, IIa, and IIb)

Data Review Process Inputs		Step I Verification	Step IIa Compliance	Step IIb Comparison	Step III Usability
Planning Documents					
1	Evidence of required approval of plan (QAPP)	X			Uses Outputs from Previous Steps
2	Identification of personnel (those involved in the project and those conducting verification steps)	X			
3	Laboratory name	X			
4	Methods (sampling and analysis)	X	X		
5	Performance requirements (including QC criteria) for all inputs	X	X	X	
6	Project quality objectives	X		X	
7	Reporting forms	X	X		
8	Sampling plans, location, maps, grids, and sample ID numbers	X	X		
9	Site identification	X			
10	SOPs (sampling and analytical)	X	X		
11	Staff training and certification	X			
12	List of project-specific analytes	X	X		
Analytical Data Package					
13	Case narrative	X	X	X	Uses Outputs
14	Internal laboratory chain of custody	X	X		

QAPP Worksheet #34 – Verification (Step I) Process Table (continued)

Data Review Process Inputs		Step I Verification	Step IIa Compliance	Step IIb Comparison	Step III Usability
15	Sample condition upon receipt, and storage records	X	X		from Previous Steps
16	Sample chronology (time of receipt, extraction, and analysis)	X	X		
17	Identification of QC samples (sampling or lab, temporal, and spatial)	X	X		
18	Associated (batch or periodic) Performance Testing sample results	X	X	X	
19	Communication logs	X	X		
20	Copies of laboratory notebook, records, prep sheets	X	X		
21	CA reports	X	X		
22	Definitions of laboratory qualifiers	X	X	X	
23	Documentation of CA results	X	X	X	
24	Documentation of individual QC results (e.g., spike, duplicate, LCS)	X	X	X	
25	Documentation of laboratory method deviations	X	X	X	
26	EDDs	X	X		
27	Instrument Calibration Reports	X	X	X	
28	Laboratory name	X	X		
29	Laboratory sample identification numbers	X	X		
30	QC sample raw data	X	X	X	
31	QC summary report	X	X	X	
32	Raw data	X	X	X	
33	Reporting forms, completed with actual results	X	X	X	
34	Signatures for laboratory sign-off (e.g., laboratory QA/QC Manager)	X	X		
35	Standards traceability records (to trace standard source from National Institute of Standards and Technology (NIST), for example)	X	X	X	
Sampling Documents					

QAPP Worksheet #34 – Verification (Step I) Process Table (continued)

Data Review Process Inputs		Step I Verification	Step IIa Compliance	Step IIb Comparison	Step III Usability
36	Chain of custody	X	X		
37	Communication logs	X	X		
38	CA reports	X	X	X	
39	Documentation of CA results	X	X	X	
40	Documentation of deviation from methods	X	X	X	
41	Documentation of internal QA review	X	X	X	
42	EDDs	X	X		
43	Identification of QC samples	X	X	X	
44	Meteorological data from field (e.g., wind, temperature)	X	X	X	
45	Sampling instrument decontamination records	X	X		
46	Sampling instrument calibration logs	X	X		
47	Sampling Location and Plan	X	X	X	
48	Sampling notes and drilling logs	X	X	X	
49	Sampling report (from Field PM to PM describing sampling activities)	X	X	X	
External Reports					
50	External audit report	X	X	X	Uses Outputs from Previous Steps
51	External proficiency testing sample results	X	X		
52	Laboratory certification	X	X		
53	Laboratory QA plan	X	X		
54	Method Detection Limit study information	X	X	X	
55	NELAP accreditation	X	X		

CA = corrective action

EDD = electronic data deliverable

NELAP = National Environmental Laboratory Accreditation Program

PM = Project Manager

QA = quality assurance

QC = quality control

RPM = Remedial Project Manager
SOP = standard operating procedure

QAPP Worksheet #35 – Validation (Steps IIa and IIb) Process Table

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Methods	Check that the methods used were those specified by the QAPP.	Data Validation/Chemist, Field PM
IIa/IIb	Performance Requirements	Check that the performance requirements specified by the QAPP are met.	Data Validation/Chemist, Field PM
IIa	Report Forms	Check that the report forms are filled out completely and as required by the QAPP, method, or guidance documents.	Data Validation/Chemist, Field PM
IIa	Sampling plans, location, maps, grids, and sample ID numbers	Check that the specifications for these items were met as described by the project planning documents and work instructions.	Data Validation/Chemist, Field PM, PM, Sampling Team peer review
IIa	SOPs (sampling and analytical)	Check that the requirements as specified by these documents were met and that the methods and SOPs referenced and contained in the QAPP were applied to the data.	Laboratory personnel, Data Validation/Chemist, Field PM
IIa	Project specific analytes	Check that the project specific analytes were reported as listed in the planning documents, specifically the QAPP.	Laboratory personnel, Technical PM, Data Validation/Chemist
IIa/IIb	All required elements of the data package	Check that all of the required reporting elements are present in the laboratory data package.	Laboratory personnel, Data Validation/Chemist
IIa/IIb	Sampling /Field Documents	Check that all of the required criteria and specifications for field practices surrounding sample collection, shipping, and handling are met as specified by the project planning documents. All field documentation will be reviewed including but not limited to: chains of custody, communication logs, CA reports, documentation of field and method variances, documentation of internal QA review, EDDs review, field logs, forms, and notebook review, field calibration records, and daily field reports.	Field PM, Data Validation/Chemist, PM
IIa/IIb	External Reports	Check that external reports created for and by the project such as external audit reports, laboratory assessment, performance testing, and NELAP accreditation support the requirements of the QAPP.	Data Validation/Chemist

Data Validation

During data validation, the evaluation of the data will extend beyond method, procedural, or contractual compliance (verification) to check the analytical quality of the specific data set. The data will be evaluated with regard to compliance to the DQOs and measurement quality objectives. During data validation, data qualifiers will be assigned to provide the basis of describing data quality. Should non-conformance issues be generated from the laboratory the validation procedure evaluates the impacts of the nonconformance(s) on the quality and usability of the data set.

Step IIa denotes a list of validation activities which include the following and are associated with Methods, Procedures, and Contracts (MPC):

- Data Deliverables – Check that all required information on sampling and analysis are provided.
- Analytes – Check that all analytes were reported as required.
- Chain of custody – Evaluate traceability of data and examine against procedural requirements.
- Holding times – Check holding times for analysis.
- Sample Handling – Check that sample preservation, handling, and storage procedures were met.
- Sampling Methods and Procedures – Check that field measurement and performance criteria were met, or documented if they did not meet specifications. Check that required sampling methods were used.
- Field Transcription – Check transcription accuracy of sampling data where applicable.
- Analytical Methods and Procedures – Evaluate whether the required methods and procedures were performed.
- Data Qualifiers – Check that the laboratory qualifiers were used correctly.
- Laboratory Transcription – Check accuracy of transcription where applicable.
- Proficiency Testing – Evaluate acceptance of proficiency testing sample results against performance requirements as specified by the project.
- Standards – Check that standards are traceable and meet project and contract requirements.
- Communication – Check that required communication procedures were followed by field and laboratory personnel.

Step IIb denotes a list of validation activities which include the following and are associated with comparison with MPC in the QAPP:

- Data Deliverables and QAPP – Check that data report from Step IIa was provided.
- Field Sampling Plan – Check whether the sampling plan was executed as specified.
- Sampling Procedures – Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support.
- Co-located Field Duplicates – Compare results of collocated field duplicates with criteria established in the QAPP.
- Project Quantitation Limits – Check that quantitation limits were achieved as outlined in the QAPP and that the laboratory successfully analyzed a standard at the quantitation limit.
- Confirmatory Analysis – Evaluate the agreement of the laboratory results.
- Performance Criteria – Evaluate QC data against project specific performance criteria in the QAPP (i.e. evaluate quality parameters beyond those outlined in the methods).
- Data Qualifiers – Check that the data qualifiers applied in Step IIa were those specified in the QAPP and that any deviations were specified.
- Step IIb Validation Report – Summarize outcome of comparison of data to MPC in the QAPP, and include qualified data and explanation of all data qualifiers.

CA = corrective action
DQO = data quality objective
MPC = methods, procedures and contracts
NELAP = National Environmental Laboratory Accreditation Program
PM = Project Manager
QA = quality assurance
QC = quality control
SOP = standard operating procedure

QAPP Worksheet #36 – Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa/IIb	All matrices collected per the QAPP	All analytical parameters	N/A	Criteria cited in the QAPP, EPA Region 2 Validation Criteria, Method and SOP criteria, and the current National Functional Guidelines for Data Validation.	Validation Team, QA Manager (TBD)

[1]Concentration Range "ICP-AES" includes mercury by CVAA and cyanide by spectrophotometer as per EPA CLP ILM05.4 .

Data Validation

Analytical data will be validated per the validation standard operating procedures listed by EPA Region 2 under the Resource Conservation and Recovery Act and the Comprehensive Engironmental Response, Compensation, and Liability Act Field and Data Validation Standard Operating Procedures (http://www.epa.gov/region2/qa/documents.htm), the National Functional Guidelines for Contract Laboratory Program Data Review, and against the specific laboratory supplied analytical and sample preparation standard operating procedures. Field data will also be validated against the standard operating procedures and acceptance criteria contained in the project specific Uniform Federal Policy QAPP.

The proposed validation approach will include 100% (full) data validation for the data collected under the current scope of the PDWP. Full Contract Laboratory Program (CLP) or CLP-like data packages will be received for all of the analytical data regardless of the level of validation being performed on the data. This will ensure full hard copy back up of all reported data results.

CLP = Contract Laboratory Program
CVAA = cold vapor atomic absorption
ICP-AES = inductively coupled plasma atomic emission spectroscopy
N/A = not applicable
PDWP = Pre-Design Work Plan
QA = quality assurance
SOP = standard operating procedures
TBD = to be determined

QAPP Worksheet #37 – Usability Assessment

To the extent possible, the Consultant will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA QA/G-9R Data Quality Assessment, A Reviewer's Guide, February 2006. The DQA process includes five steps: 1) review the data quality objectives (DQOs) and sampling design; 2) conduct a preliminary data review; 3) select a statistical test; 4) verify the assumptions of the statistical test; 5) draw conclusions from the data.

After the data are received from the fixed based laboratory, data validation of the data will occur as described in Worksheet #36. During validation, where necessary, validation qualifiers will be applied to the data indicating that it has limited use, should perhaps be examined more closely, or has dramatically failed one or more data quality indicator criteria and has been rejected. This information will be supplied to the project team via a validation report and to the data manager through updates to the data base. A DQA Report will be prepared on a periodic basis summarizing the overall quality of the data including field data, field quality control (QC) data, laboratory QC data, and laboratory data. This will further illustrate the limitations of any qualified data that may have resulted during data validation.

It is incumbent on the project team to then utilize the data in an appropriate manner based on any limitations that have been identified.

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

Data usability is the process of evaluating the data validation results and determining the confidence with which any data point(s) may be used. Usability is determined by evaluating the data validation qualifier applied and the laboratory QC results. Concentration values may be considered to have a high degree of confidence because the associated method performance criteria were achieved. Estimated concentration results are evaluated with respect to the bias contributed to the value by the associated QC result. Bias direction can be estimated for data quality impacts due to surrogate recoveries, matrix spike (MS) recoveries, and laboratory control sample (LCS) recoveries. Sample concentration results that are rejected during data validation are not used in the decision-making process and should not be reported.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

Data usability is evaluated with respect to the DQOs developed in this QAPP to check that the opportunity for incorporating unacceptable and manageable error into the decision-making process is minimized to the extent possible. The DQOs for this project are contained in Worksheet #11.

All analytical data, data validation qualifiers, and QC results will be evaluated to determine the confidence with which the analytical data can be used in the project decision-making process. The criteria used in the data usability summary are presented as follows using the data quality indicator criteria required for this project and measured as precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS).

1.0 PARCCS Overview

1.1 Introduction

This quality assurance (QA) program addresses both field and laboratory activities. QA objectives are formally measured through the computation of performance measures known as data quality indicators (DQIs), which are in turn compared to pre-defined measurement quality objectives (MQOs) specific to the project objectives. The DQIs for measurement data are expressed in terms of PARCCS. Evaluation of DQIs provides the mechanism for on-going control and evaluation of data quality throughout the project and ultimately will be used to define the data quality achieved for the various measurement parameters. The field QA/QC program will be accomplished through the collection of field duplicates and trip blanks. The analytical QA/QC program will be assessed through the internal laboratory QC performed, including method blanks, LCS recoveries, surrogate recoveries, and matrix spike/matrix spike duplicate (MS/MSD) recoveries. The following sections describe the DQIs in greater detail, with a discussion of the associated MQOs.

1.2 Precision

Precision refers to the reproducibility or degree of agreement among duplicate measurements of a single analyte. The closer the numerical values of the measurements, the more precise the measurement. Poor precision stems from random errors (i.e., mechanisms, which can cause both high and low measurement errors at random). Precision is usually stated in terms of standard deviation, but other estimates, such as the coefficient of variation, range (maximum value minus minimum values), and relative range are common, and may be used pending review of the data.

Precision will be checked through the collection of field duplicates and the analysis of MS/MSD and laboratory control sample/laboratory control sample duplicates (LCS/LCSD) samples for the work performed at the Site. The overall precision of measurement data is a mixture of sampling and analytical factors. Analytical precision is much easier to control and quantify than sampling precision; there are more historical data related to individual method performance, and the "universe" is not limited to the samples received in the laboratory. In contrast, sampling precision is unique to the project. Sampling precision will be measured through the laboratory analysis of field duplicate samples. Laboratory precision will be measured through the analysis of MS/MSD and LCS/LCSD samples.

During the collection of data using field methods and/or instrumentation, precision is checked by reporting several measurements taken at one location and comparing the results. Precision will be determined from duplicate samples and will be expressed as the RPD between replicate/duplicate sample results, computed as follows:

$$RPD = \frac{X_1 - X_2}{\left(X_1 + X_2\right) / 2} \times 100$$

where X_1 and X_2 are reported concentrations for each replicate sample and subtracted differences represent absolute values. For field duplicates, the precision goals for this project are RPD = 30% for water samples. For laboratory duplicates, the RPD goals are dictated by the specific analytical and laboratory QC acceptance criteria.

1.3 Accuracy and Bias

Accuracy refers to the degree of difference between measured or calculated values and the true value. The closer the numerical value of the measurement comes to the true value, or actual concentration, the more accurate the measurement. The converse of accuracy is bias, in which a systematic mechanism tends to consistently introduce errors in one direction or the other. Bias in environmental sampling can occur in one of three ways; these mechanisms and their associated diagnostic and management methods are as follows:

- High bias, which can stem from cross-contamination of sampling, packaging, or analytical equipment and materials. Cross-contamination is monitored through blank samples, such as equipment blanks, trip blanks, and method blanks. These samples assess the potential for cross-contamination from, respectively, sampling equipment, ambient conditions, packaging and shipping procedures, and laboratory equipment. Data validation protocols described in Worksheet #36 present a structured approach for data qualification based on blank samples.

- Low bias, which can stem from the dispersion and degradation of target analytes (e.g., volatilization of chlorinated solvents during field sampling). The effects of these mechanisms are difficult to quantify. Sampling accuracy can be maximized, however, by the adoption and adherence to a strict field QA program. Specifically, sampling procedures will be performed following standard protocols described in the QAPP. Through regular review of field procedures, deficiencies will be documented and corrected in a timely manner.

- High or low bias may occur due to poor recoveries, poor calibration, or other system control problems. The effects of these mechanisms on analytical accuracy may be expressed as the % recovery of an analyte that has been added to the environmental sample at a known concentration before analysis. Analytical accuracy in the laboratory will be determined through the analysis of LCSs and MS/MSDs. As with blank samples, data validation protocols provide a structured formula for data qualification based on erroneously high or low analyte recoveries.

Accuracy, when potentially affected by high or low recoveries as described in the third bullet above, is presented as percent recovery (%R), defined as:

$$\%\,R = \frac{Spiked\ Sample\ Concentration - Sample\ Concentration}{Spike\ Concentration} \times 100$$

Accuracy goals are presented as upper and lower control limits for percent recovery and are generated through the compilation of control charts and referenced in each laboratory method SOP attached to this QAPP.

1.4 Representativeness

Representativeness is defined by the degree to which the data accurately and precisely describe a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. If the results are reproducible, the data obtained can be said to represent the environmental condition. Representativeness is evaluated by collecting sufficient numbers of samples of an environmental medium, properly chosen with respect to place and time. The precision of a representative set of samples reflects the degree of variability of the sampled medium, as well as the effectiveness of the sampling techniques and laboratory analysis.

1.5 Completeness

Completeness is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is essentially the same for all data uses in that sufficient amounts of valid data are to be generated.

There are limited historical data on the completeness achieved by individual methods. However, the Contract Laboratory Program data have been found to be 80 to 85% complete on a nationwide basis. The percent completeness for each set of samples will be calculated as follows:

$$\%\ Completeness = \frac{Valid\ \ Data}{Total\ \ Data\ \ Planned} \times 100$$

The QA objective for completeness for all parameters will be 90%.

1.6 Comparability

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is evaluated through the use of established and approved analytical methods, consistency in the basis of analysis (e.g., wet weight, volume), consistency in reporting units (µg/L, mg/L), and analysis of standard reference materials. By using standard sampling and analytical procedures, data sets will be comparable.

1.7 Sensitivity

Sensitivity refers to the minimum magnitude at which analytical methods can resolve quantitative differences among sample concentrations. If the minimum magnitude for a particular analytical method is sufficiently below an action level or risk screening criterion, then the method sensitivity is deemed sufficient to fully evaluate the dataset with respect to the desired reference values. Frequently, risk-based screening levels fall below the sensitivity of even the most sensitive analytical methods. In such cases, it is necessary to review the qualifications of several laboratories, both from the standpoint of sensitivity as well as other DQIs, to select the best laboratory for the project.

The MDL is a theoretical limit determined through an MDL study, in which the concentration of a spiked solution is tested at least seven times. The standard deviation of the recovered concentrations (σ_{rec}) is computed and multiplied by the t-distribution value to arrive at the MDL. In practice, to allow for matrix interferences variability in instrument control, a reporting limit of 2.5 to 5 times the MDL is typically selected.

Analytical sensitivity is readily evaluated by comparing method reporting limits to risk-based screening values. The results of this analysis are presented in Worksheet #15, which demonstrate the suitability of the selected methods to the project requirements.

1.7.1 Identify the personnel responsible for performing the usability assessment:

Data usability is first evaluated by the laboratory performing the fixed base analysis, the data validation team, and the QA Manager. Usability of data collected in the field is first determined by the field team and Field PM. Once the data are validated the usability of the data are determined by the project team, specifically the technical leaders for the project and the PM.

1.7.2 Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

Data usability will be documented through validation reports as well as through the issuance of DQA Reports, which will summarize how the data reflect the specific criteria for the data quality indicators assigned to the project.

DQA = data quality assessment
DQO = data quality objective
DQI = data quality indicator
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
MS = matrix spike
MSD = matrix spike duplicate
MQO = measurement quality objectives
PARCCS = precision, accuracy, representativeness, completeness, comparability, and sensitivity
PM = Project Manager
QA = quality assurance
QC = quality control

ATTACHMENT A

FIELD SAMPLING PLAN

Prepared for

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ATTACHMENT A
FIELD SAMPLING PLAN

GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

Prepared by

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engineers | scientists | innovators

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LIST OF ACRONYMS

AOC	Administrative Order and Settlement Agreement
CPT	Cone penetration test
EPA	Environmental Protection Agency
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet
GPS	Global Positioning System
ID	identification
NAPL	non-aqueous phase liquid
NYC	New York City
NYSDEP	New York State Department of Environmental Protection
OTS	oxygen transfer system
PAH	polycyclic aromatic hydrocarbon
PD	pre-design
PDWP	Pre-Design Work Plan
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RTA	Remediation Target Area
SOP	Standard Operating Procedure
SOW	Scope of Work
SVOC	semi-volatile organic compound
TAL	target analyte list
TCL	target compound list
TarGOST ®	Tar-specific Green Optical Screening Tool
UV	ultraviolet
UVOST ®	Ultraviolet Optical Screening Tool
VOC	volatile organic compound

SECTION 1

OVERVIEW

This Field Sampling Plan (FSP) has been prepared by Geosyntec Consultants, Inc. (Geosyntec) in consultation with National Grid for the Gowanus Canal Superfund Site (the Site) under the Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation dated April 29, 2010, as amended on January 24, 2014 (the AOC) by the United States Environmental Protection Agency (EPA). This FSP addresses only those portions of the Pre-Design Work Plan (PDWP) detailed in the scope of work (SOW) attached to the AOC Amendment (Geosyntec Consultants, 2014). This FSP is a necessary step in the initial development of the technical activities required by the Record of Decision (ROD) dated September 27, 2013, and provides the framework needed to guide field activities associated with pre-design (PD) tasks PD-3 through PD-8 of the PDWP.

This FSP, which serves as Attachment A to the Quality Assurance Project Plan (QAPP), is a companion to the PDWP. The FSP describes field activities for the pre-design work to be completed at Gowanus Canal. The rationale for the field activities is provided in the PDWP and Worksheet #17 of the QAPP. Revisions to this FSP are anticipated for additional phases of work and will be submitted to the EPA and the New York State Department of Environmental Protection (NYSDEP) for review and approval.

1.1 Site Setting and Background

Gowanus Canal is located in Kings County, New York (PDWP Figure 2-1). The EPA Feasibility Study (FS, CH2M Hill, 2011) divided the Canal into three remediation target areas (RTAs) that correspond to the upper reach (RTA 1), middle reach (RTA 2), and lower reach (RTA 3) of the Canal in order to facilitate the assessment and management of the Canal (PDWP Figure 2-2).

Additional details regarding the Site setting and background are found in Section 2 of the PDWP.

1.2 Field Sampling Plan Organization

This FSP describes each of the major components of the field investigation program to be conducted during the PDWP implementation and includes PD investigations PD-3 through PD-8 as listed below:

- PD-3: Additional Reconnaissance for Debris Removal;
- PD-4: A Plan for Debris Removal, Decontamination, and Disposal;
- PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation;

- PD-6: A Plan for Staging Site Selection and Implementation;

- PD-7: Evaluation of Potential Groundwater Upwelling Areas and Measurement of Groundwater Discharge Rates; and

- PD-8: Evaluation of Potentially Mobile non-aqueous phase liquids (NAPL) in Native Sediments.

While field characterization will be performed for each of these tasks as is described in general terms in this FSP, the exact scope is dependent upon information gathered in desktop studies and field conditions and hence has yet to be developed fully; the resulting scope of work will be discussed with EPA. FSP revisions will be submitted as needed to address additional items.

QAPP Worksheet #18 provides a format for listing sampling locations, nomenclature, and analytical program by task and subtask. QAPP Worksheet #19 provides information relating to analytical sample container, sample volume, preservation, and holding time requirements. QAPP Worksheet #20 summarizes the field Quality Assurance/Quality Control (QA/QC) sample requirements. These worksheets will be more completely populated following further task development.

This FSP document refers to Standard Operating Procedures (SOPs) for specific instructions for the completion of several tasks. The SOPs are located in Attachment B of the QAPP and include the following:

- Standard Operating Procedure No. 100: Recording Station Location Position with a Global Positioning System (GPS);

- Standard Operating Procedure No. 101: Field Documentation, Sample Designation, Custody and Handling Procedures;

- Standard Operating Procedure No. 102: Procedure to Prepare Samples for Shipment;

- Standard Operating Procedure No. 103: Decontamination Procedure for Sampling Equipment;

- Standard Operating Procedure No. 104: Management and Disposal of Investigation-Derived Waste; and

- Standard Operating Procedure No. 105: Procedure to Conduct a Technical System Field Audit.

Additional SOPs will be developed upon further development of each task.

SECTION 2

PD-3: ADDITIONAL RECONNAISSANCE FOR DEBRIS REMOVAL

The PD-3: Additional Reconnaissance for Debris Removal work element (hereafter referred to as PD-3) will seek to perform additional debris reconnaissance for debris removal in the Canal in areas not previously surveyed or where survey results require confirmation.

During the December 2010 Remedial Investigation/Feasibility Study (RI/FS) side-scan sonar study, several areas of the Canal were not evaluated due to interferences which resulted in data gaps in the current understanding of debris conditions existing at the Canal (Dolan Research, 2010). This debris reconnaissance work element will be performed to address the areas of the Canal not previously evaluated in the December 2010 study to identify and characterize Site conditions, anomalies, obstructions, and potential submerged cultural resources in these areas.

The areas of the Canal which were unable to be previously evaluated due to interferences and related mitigating measures are presented in Table 1.

Table A1 – Mitigating Measures to Evaluate Debris

Previous Interference	Mitigating Measure
Various locations between the 3rd Street Bridge and head of the Canal could not be investigated due to the presence and operation of the oxygen transfer system (OTS).	The OTS system will be removed prior to the additional reconnaissance activities.
Double-berthed construction and work barges prevented comprehensive acoustic coverage at several locations at the mouth of the Canal.	The activities will be coordinated to occur when the mouth of the Canal is free of construction equipment and work barges.
Differential Global Positioning System limitations while navigating under the five bridges created fragmented sonar coverage at these locations.	Alternatives to side-scan sonar may be used, such as a tripod-mounted, high-resolution, 360-degree scanning sonar which can be deployed adjacent to hard-to-reach areas to generate plan-view sonar imagery.

Verification will be performed for significant debris fields identified during this effort and in previous surveys. As obstructions are identified during the supplemental reconnaissance/side-scan sonar study, they will be characterized as appropriate by material (e.g. timber, metal, concrete, or tires). The obstructions will then be added to the scope of the Plan for Debris Removal, Decontamination, and Disposal (PD-4) as well as the subject of future cultural resources assessments if warranted.

A qualified subcontractor will conduct the additional reconnaissance activities.

SECTION 3

PD-4: A PLAN FOR DEBRIS REMOVAL, DECONTAMINTATION, AND DISPOSAL

The overall objective of this work element is to develop a plan to govern the removal and/or management of debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated. Details of each component are addressed in the sections below.

3.1 Debris Removal and Management

Debris removal and management will be conducted with an adaptive management approach in the field. Material removed will be identified during a reconnaissance phase, to the extent practical, and a plan for the equipment and removal methods will be created in advance. The dredging contractor will retain the flexibility to make real-time field decisions in coordination with the consultant field team leader as additional data become available during debris removal operations. The specifics of what debris will be removed prior to remedial dredging and what debris will be removed by the dredge itself may be modified to address real-time field conditions encountered during debris removal and/or dredging.

Debris removal operations will be accomplished through the use of barge-mounted cranes and/or excavators using various types of attachments, such as environmental buckets, grapples, clam shells, and rakes.

To the extent possible, and after any cultural resources have been addressed, all the debris present at the targeted locations identified in the 2010 sonar study (Dolan Research, 2010) and supplemental debris investigations will be raked at a minimum.

Media separation (sediment and water) will be required for much of the debris removed. Debris found to be coated in sediment residue will be suspended over the water in the area from which it originated and rinsed using Site water via an engine driven pump with an attached fire hose. Sufficient rinse time will be allowed to remove residual sediment, or the debris will be placed on a rack (i.e., grizzly screen) where it can be raked to remove hardened sediment.

3.2 Debris Handling and Disposal

To the extent possible, debris removal and management activities will be performed in or upon the water. Removed debris will likely be placed onto a transfer barge, and the barge or series of barges will serve as a management staging area where debris will be sorted based on material composition and size prior to offloading. Ideally, debris will be transported by barge to the permitted processing facility or facilities.

Debris removed from the Canal will be subjected to the conditions of the operating permits of the off-loading, processing, treatment and transfer facility or facilities that will be engaged and/or retained as part of this project. Regulated debris collected during operations will be handled by trained personnel and disposed of in accordance with all federal, state and local regulations and ordinances.

Several emission mitigation steps will be identified and implemented as needed to minimize the generation of odors. These mitigation strategies may include:

- Application of odor suppressants/foaming agents;
- Covering of the debris stockpiles on barges;
- Minimization of debris storage/stockpiling areas on barges or near shorelines; and
- Covering of debris trucks/containers during transport from the barge offloading area to the sediment consolidation area.

3.3 Cultural Resources Management

The primary objective of cultural resource management, as it pertains to the remedy implementation, is to remove any cultural resources so the resources can be preserved, to the extent practical, and to ensure that targeted sediment can be efficiently and effectively remediated. If removal of cultural resources is not feasible, the resource may require management in place.

SECTION 4

PD-5: DETAILED SURVEY AND ASSESSMENT OF EXISTING BULKHEADS FOR REMEDY IMPLEMENTATION

The overall objectives of the bulkhead survey and assessment work element are to assess the expected stability of existing bulkheads during and after remedy implementation, and to create a design of temporary and permanent bulkhead support systems.

To meet the stated objectives, several sub-tasks with a field work component have been identified that will be performed under this work element including subsurface investigation of existing bulkhead foundations and Geotechnical Site Investigations. Details of each sub-task are provided in the sections below.

4.1 Subsurface Investigation of Existing Structures

4.1.1 Subsurface Investigation of Existing Bulkhead Foundations and Conditions

This sub-task has been developed to address the data gaps related to bulkhead foundation depth and bulkhead conditions below the water-line. The condition of existing bridge foundations and abutments will also be determined as part of the investigation, although their assessment will be deferred to New York City (NYC).

The bulkheads along the Canal have been divided into four category types: (1) timber cribs; (2) timber pile foundations; (3) steel sheet piles; and (4) embankments and failed bulkheads. Several subsurface exploration methods will be used in the subsurface investigation of the bulkhead foundations, including:

- **Divers performing physical inspection and probing**: Divers allow for an accurate estimate of the integrity and condition of bulkheads below the water level and above the sediment/mud line. Probing may allow divers to determine approximate bottom of timber cribbing bulkheads. This exploration method will be performed at select locations along the Canal. Divers will document the conditions of each bulkhead and follow an SOP that will be developed prior to the start of the task.

- **Downhole seismic testing:** Downhole seismic testing (ASTM D7400) will be performed at timber pile bulkheads and steel sheet pile bulkheads as a means of determining the location of the bottom of foundations. For each test, one boring or cone penetration test (CPT) with a horizontal shear wave receiver will be performed within approximately 5 feet (ft) from either the Canal-side or upland of the bulkhead pile being investigated. The test is performed by inducing a seismic source at the top of the bulkhead pile being investigated while a downhole receiver is deployed at selected depths to detect the arrival of horizontal shear waves emitting from the source pile. The depth at which there is significant loss of shear wave energy (reduction or complete loss of signal in the receiver) should coincide with the bottom of the bulkhead pile foundation.

Due to the potential existence of buried timber bulkhead structures on the upland side of the bulkhead, results will likely be improved by performing tests on Canal side of the bulkheads. If a CPT is performed, the procedure will follow ASTM D5778. Borings will be drilled and logged as discussed in ASTM D6151, ASTM D5783, and ASTM D5753. All recovered soil samples will be labeled and handled as discussed in ASTM D4220. Laboratory testing of recovered samples will be performed as part of the Geotechnical Site Investigation, Section 4.2. All CPT results, boring logs, and the soil test data will be included as part of the Geotechnical Site Investigation. Note that Site access restrictions or existing obstructions may limit test performance.

- **Crosshole seismic testing**: Crosshole seismic testing (ASTM D4428) will be performed at timber cribbing bulkheads, timber pile bulkheads, and steel sheet pile bulkheads to determine the location of the bottom of the bulkhead foundations. The testing will performed at two borings located 5 to 10 ft away from and surrounding the bulkhead of investigation. A seismic source will generate waves at a selected depth down one of the borings, and downhole receivers in the other boring will be used to detect the arrival of the seismic waves. The time required for the shear wave to travel from the source to the receivers is used to calculate the shear wave velocity through the soil and bulkhead. Sharp variations in the shear wave velocity with depth should correspond with the bottom of the bulkhead foundation.

  At least two borings will be drilled and logged per test location as discussed in ASTM D6151, ASTM D5783, and ASTM D5753. All recovered soil samples will be labeled and handled as discussed in ASTM D4220 and per SOP 101. Laboratory testing of recovered samples will be performed as part of the Geotechnical Site Investigation, Section 4.2. Borings and soil test data will be included as part of the Geotechnical Site Investigation. Note that Site access restrictions or existing obstructions may limit test performance.

- **Low strain impact integrity testing of deep foundations:** Low strain impact integrity testing (ASTM D5882) will be performed at timber pile and steel sheet pile bulkheads as a means to determine the depth of the pile tips. A hand held hammer or similar impact source with a trigger will be used to generate a force pulse at the top of the pile. This impact may be induced either axially and/or perpendicularly to the head of the pile. Transducers will be placed at the head of the pile to measure velocity and force response of the pile. The velocity and force response will be recorded as a function of time and can be used to provide an indication of the pile length based on pile material assumptions. This test method requires unobstructed access to the top of the piles; therefore, existing field conditions may limit test performance.

- **Borehole induction method**: This exploration method will be performed at steel sheet pile bulkheads as a means to determine the depth of the pile tips. An adaptation of ASTM D6726 and ASTM D5753 that will be developed as an SOP prior to the start of the task will be followed. The test will be performed within a radius of 5 ft from either the Canal-side or upland of the bulkhead pile under investigation. A drilled borehole or a CPT probe will be used to insert an induction probe into the subsurface to create a magnetic field and induce eddy currents in surrounding material. The probe measures the secondary magnetic field created by the eddy currents in order to determine the resistivity of the material. This test is performed with depth and sharp variations in the resistivity should indicate the bottom of the steel sheet pile foundation.

  Due to the potential existence of buried timber bulkhead structures upland of the bulkhead, results will likely be improved by performing tests on Canal-side of the bulkheads. If a CPT is performed, the procedure will follow ASTM D5778. Borings will be drilled and logged as discussed in ASTM D6151, ASTM D5783, and ASTM D5753. All recovered soil samples will be labeled and handled as discussed in ASTM D4220 and per SOP 101. Laboratory testing of recovered samples will be performed as part of the Geotechnical Site Investigation, Section 4.2. All CPT results, boring logs, and the soil test data will be included as part of the Geotechnical Site Investigation. Note that Site access restrictions or existing obstructions may limit test performance.

Due to high levels of uncertainty associated with the effectiveness of each technique, a methods development program is being designed to determine which technique will be applied for each bulkhead type. For each bulkhead category, the following subsurface exploration methods will be attempted as part of the pilot for the field investigation:

- **Type 1: Timber cribs**: Divers performing physical inspection and probing and crosshole seismic testing;

- **Type 2: Timber piles**: Divers performing physical inspection, crosshole seismic testing, downhole seismic testing, and low strain impact integrity testing of deep foundations;

- **Type 3: Steel sheet piles**: Divers performing physical inspection, crosshole seismic testing, downhole seismic testing, and borehole induction method; and

- **Type 4: Embankments and failed bulkheads**: No further inspection of foundation, assumed to require a permanent replacement bulkhead.

The current investigation plan is based on the assumption that each bulkhead requires investigation. SOPs adapted from listed ASTMs may be developed, or existing SOPs may be revised to address issues observed during the methods development program. New or revised SOPs will be prepared prior to commencing the Site-wide bulkhead investigation. At least one technique will be used at each bulkhead identified as requiring investigation. Target investigation locations will determined prior to commencing this task.

4.1.2 Subsurface Investigation of Bridge Foundations and Conditions

Five surface streets cross over the Canal with bridges (five streets accounts for the divided Hamilton Avenue crossing). The condition of bridge foundations and abutments will be included in this study.

Appropriate NYC representatives will be contacted for information on the bridge foundations and abutments. If sufficient information is available a field investigation may not be warranted; otherwise the methods described herein will be used to investigate the bridges and abutments. Final assessment of bridge stability during remedial actions will be the responsibility of NYC.

4.1.3 Combined Sewer Overflow Investigation

Various pipe discharge outfalls identified by EPA in Appendix G of the RI (CH2M Hill and HDR, 2011) will be verified and their conditions noted during the field investigation.

4.2 Geotechnical Site Investigation

Geotechnical Site Investigation subsurface exploration methods include borehole drilling and CPT sounding. Borings will be performed in accordance to the procedures discussed in ASTM D6151 and/or ASTM D5783. CPTs will be performed in accordance with the procedure discussed in ASTM D5778.

The Geotechnical Site Investigation includes the following:

- Sampling locations will be selected at approximately 100 ft intervals along the length of the bulkheads. Sampling locations will consist of two points oriented perpendicularly to the bulkhead under investigation with one sample collected approximately 5 ft laterally from the bulkhead (located either upland of the bulkhead or Cana-side of the bulkhead) and one sample collected approximately 50 ft laterally upland from the bulkhead:
    - One "shallow" boring will be collected to a depth 10 ft deeper than the estimated bottom of the bulkhead based on the desktop study. These borings will be offset approximately 10 ft laterally from the bulkhead so that they pass through fill material.
    - One CPT sounding will be attempted to a target depth of 70 ft bgs except where "deep" borings will be performed. CPT locations will be offset approximately 50 ft laterally from the bulkhead in line with the "shallow" borings. If a CPT cannot be completed to the target depth, then the boring depth will be altered to match that of the nearby "shallow" sample. Shear wave testing will be performed at select CPT locations.
    - One "deep" boring will be collected to a target depth of 70 ft. These borings will be collected in place of CPT samples approximately every 400 ft along the length of the bulkheads and will be offset approximately 50 ft laterally from the bulkhead.

Boring samples will be recovered and logged according to ASTM D5753. Sample documentation includes: (i) field soil classification of each recovered sample; (ii) photo documentation of each recovered soil sample; and (iii) hand written boring log for each boring including descriptions of soil samples, observations made during drilling, drilling recoveries, blow counts, and any irregularities experienced during drilling.

For all borings and CPT soundings performed, the proposed locations may require adjustment depending on Site access restrictions and subsurface obstructions. All holes created during boring collection will be backfilled with a tremie-placed grout-bentonite mixture and all CPT holes will be backfilled with hydrated bentonite.

A laboratory testing program will be performed on select samples. Disturbed soil samples for geotechnical testing will be recovered via split spoon sampling and collected in jars labeled with the boring identification (ID), sample ID, sample depth, standard penetration test blow counts, and sample recovery, as discussed in ASTM D4220. Undisturbed sampling locations will be selected at the discretion of the Field Engineer based on encountered field conditions. Undisturbed samples will target cohesive materials and will be recovered via piston pushed thin tubes, logged, and labeled with boring ID, sample ID, sample depth, and sample recovery as discussed in ASTM D4220 and per SOP 101. The laboratory testing program will include:

- Unconsolidated undrained triaxial testing will be performed on select undisturbed cohesive samples to determine their undrained shear strength. The testing procedure is discussed in ASTM D2850.

- Consolidated undrained triaxial testing will be performed on select undisturbed cohesive samples to determine their undrained shear strength at various effective loading conditions and drained shear strength parameters. The testing procedure is discussed in ASTM D4767.

- Moisture content testing will be performed on select disturbed and undisturbed samples, from which moisture content profiles can be created for all borings. The testing procedure is discussed in ASTM D2216.

- Atterberg limit testing will be performed on select disturbed and undisturbed samples. This testing will be used to determine the plasticity and soil classification of the samples. The testing procedure is discussed in ASTM D4318.

- Unit weight testing will be performed on select undisturbed samples, from which unit weight profiles can be created for all borings. The testing procedure is discussed in ASTM D7263.

- Grain size distribution tests will be performed on select disturbed and undisturbed samples. This testing will be used to determine soil classifications of the samples. The testing procedure is discussed in ASTM D422.

Laboratory samples will be determined based on observed and encountered field conditions and will therefore be determined by the Field Engineer after samples have been recovered. Laboratory samples will be distributed such that soil parameters are evaluated for each identified soil layer and zone along the Canal. Information from soil borings, CPTs, field observations, and laboratory data results of selected soil test parameters will be included in existing graphical information system databases and the conceptual site model to support remedial design and decisions.

SECTION 5

PD-6: A PLAN FOR STAGING SITE SELECTION AND IMPLEMENTATION

No field work will be completed for this task prior to selecting a staging site.

SECTION 6

PD-7: EVALUATION OF POTENTIAL GROUNDWATER UPWELLING AREAS AND MEASUREMENT OF DISCHARGE RATES

The two primary objectives of this work element are to determine the approximate areas of significant groundwater upwelling in the Gowanus Canal and, for those areas where upwelling is identified, to measure the groundwater discharge rate and velocity. The term upwelling refers to general areas where groundwater discharge is occurring and the term discharge rate is used with reference to quantification of rates.

To meet the primary objectives of this work element, the following sub-tasks will be performed:

- Evaluation and selection of applicable technologies for locating groundwater upwelling areas and quantifying discharge rates;
- Evaluation and selection of areas of the Canal for groundwater upwelling measurements;
- Inspection of selected areas to confirm feasibility of selected technologies at target locations;
- Implementation of selected technologies to assess groundwater upwelling areas and discharge rates; and
- Characterization of the hydraulic conductivity between the native and soft sediments.

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications to the scope of work during implementation. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA per Worksheet #6 of the QAPP.

6.1 Evaluate and Select Applicable Technologies

Various technologies for assessing groundwater discharge will be screened for applicability in the Canal. These technologies will be evaluated for their anticipated ability to identify potential areas of groundwater upwelling and quantify groundwater discharge rates. Additionally, the detailed screening will evaluate the feasibility of implementation in the Canal and costs of implementation. Table A2 presents technology options for evaluating where groundwater upwelling may be occurring, quantifying discharge rates, and evaluating groundwater seepage velocity.

Table A2. Summary of Technologies Used to Identify and Quantify Groundwater Upwelling and Discharge Rates

Technology	Identify GW Upwelling	Quantify GW Discharge	Quantify Seepage Velocity	Description
Airborne Thermal Infrared Imaging	X			Cost effective technology that requires aircraft with sensor to detect temperature contrast at water surface that is the result of discharged groundwater. Best conducted at peak low tide during mid-winter.
Satellite Infrared Imaging	X			Data already exists and easy to implement. Best with low cloud cover, peak low tide and during either mid-winter or mid-summer. Spatial resolution may be low.
Distributed Temperature Sensing	X			Uses fiber optic cables buried in sediment to sense temperature changes assumed to be groundwater upwelling. Requires divers, but good for broad level screening. Bottom debris may hinder deployment.
Resistivity Array	X			Technique based on high resistivity contrast between groundwater upwelling and marine water. Metallic debris could be a significant problem.
Trident Probe	X			Point measurement that utilizes a sub bottom coring device to collect sediment and pore water. Groundwater upwelling areas evaluated using conductivity and temperature differentials between pore water and surface water.
Seepage Meters		X	X	Reliable method for quantifying groundwater discharge rates. Likely to require divers to implement.
Point Velocity Probes			X	New technique-monitors electrical conductivity breakthrough curves from injected saline tracer. R&D needed to implement technology in this setting.
Piezometer Nests	X	X		Although common, may be difficult due to water depth and Canal traffic. Not a direct measurement of discharge compared to seepage meters
Acoustic Doppler Current Profiling		X	X	Rapid method to assess vertical submarine groundwater discharge. Method is applicable for measuring discharges above 0.005 meters per second.
Natural Tracers	X			Uses naturally occurring, short-lived isotopic tracers that are enriched in groundwater relative to surface water to identify groundwater upwelling. May require divers to install monitoring network infrastructure. Monitoring would include intake pumps, air-water gas exchangers, and tracer-specific detectors.
In Situ Permeable Flow Sensor			X	Measures heat transport on thermistors that surround a central heating element to calculate groundwater velocity. Can be used to assess either horizontal or vertical flow depending on sensor orientation.

6.2 Evaluate and Select Areas of Canal for Groundwater Upwelling Measurements

Various surveys have been conducted in the Canal as part of the RI and supplementary data collection. This sub-task includes compiling these data sets, geo-referencing them to a common datum, and generating an interactive Site model to identify appropriate candidate areas to perform groundwater upwelling investigations in different portions of the Canal.

Specific datasets needed for this sub-task include, but are not limited to:

- Geo-referenced side-scan sonar data;
- NAPL detections in soft sediments and native sediments;
- Soft sediment scour locations;
- Magnetometer targets from the 2005 survey (GEI, 2007); and
- Updated bathymetry and sediment transport dynamics models due to potential activation of the Flushing Tunnel.

Discussions with technology vendors will inform decisions regarding Site conditions that are most appropriate for measurements. The Site model, following its development, will be used to identify areas in which field implementation is applicable. Target areas will include those within and outside of known NAPL impacts as well as areas where groundwater discharge rates are hypothesized to be high, average, and low. Areas with saturated NAPL impacts and where bottom debris is not an obstacle to technology deployment will be considered a priority. Areas potentially subject to Flushing Tunnel impacts will be evaluated for applicability. Locations with relatively little accumulation of soft sediment will be identified as areas with enhanced potential for preferential flow-paths and increased groundwater upwelling.

Side-scan and magnetometer data, collected in collaboration with PD-3, will be used to identify the presence and density of bottom debris. These data will aid in identifying areas of the Canal where physical obstacles may hinder the implementation of one or more of the identified technologies so that these locations can be avoided during field screening.

6.3 Site Visit and Inspection to Confirm Feasibility of Selected Technologies at Target Locations

Locations identified as areas to further assess groundwater upwelling, both in NAPL impacted areas and non-NAPL impacted areas, will undergo field characterization to confirm feasibility with the applicable technologies. Field characterization may include high resolution bathymetry, side-scan sonar imaging (see PD-3), and, depending on results of these surveys, diver inspection to assess the current type and magnitude of debris density and evaluate the zones of interest in order to assess whether the selected technologies can be successfully deployed. In addition, Site visits by technology vendors and subcontractors will be conducted to verify implementation feasibility and logistics as applicable.

A figure will be created which presents representative areas for study within the Canal where groundwater upwelling can be confirmed and quantified.

6.4 Implement Selected Technologies to Assess Groundwater Upwelling Areas and Discharge Rates

Technologies selected for screening will be deployed in feasible locations of interest with the intent to identify areas in which groundwater upwelling is occurring. During the implementation phase, multiple technologies will likely be used to provide independent and complementary lines of evidence to identify and characterize areas of groundwater upwelling into the Canal. The use of an initial, demonstration-scale implementation step will be considered in order to obtain Site-specific data in advance of a full-scale implementation for technologies warranting methods demonstration.

Following identification of areas of groundwater upwelling, point measurements of groundwater discharge rates and velocities across tidal cycles will be evaluated. The number of specific point measurements that will be collected will be dependent on results of the previous sub-tasks. Final determination of methods and approach will be communicated to EPA during technical workshops and or through written communications.

Detailed procedures for implementing selected technologies will be provided following the selection process.

6.5 Characterize the Hydraulic Conductivity between the Native and Soft Sediments

Possible methods for quantifying hydraulic conductivity values for the native and soft sediments include variations on CPT and slug testing as discussed in the PDWP and include:

- Hydraulic Profiling Tool by Geoprobe®;
- Waterloo Advanced Profiling System (Waterloo^{APS})^{TM};
- CPT in situ Dissipation; and
- Slug testing with nested wells.

A screening and selection of the most appropriate and informative technology will be conducted using the evaluation criteria of technical performance, implementability, and cost. Selected technologies will be implemented as discrete measurements and it is likely that more than one of these technologies will be implemented.

SECTION 7

PD-8: EVALUATION OF POTENTIALLY MOBILE NAPL IN NATIVE SEDIMENTS

The primary objectives of this work element are to (i) quantify the NAPL distribution within the Canal, (ii) define areas of potentially mobile NAPL, and (iii) identify and characterize the controlling factors of NAPL mobility.

To meet the primary objectives of this work element, the following field tasks will be performed:

- Implementation of field-based approaches selected as appropriate from a desktop evaluation to assess in situ NAPL distribution; and
- NAPL characterization and laboratory mobility testing.

Activities described for this work element are anticipated to be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work during implementation. The ultimate number of testing and sampling locations will be determined based on the following considerations and we will be added to Worksheet #18 of the QAPP: (i) the findings of the field methods desktop study (e.g., precision and sensitivity considerations); (ii) the program sequencing; and (iii) refinement of pre-design objectives. Final testing and sampling locations will be appropriately documented and communicated to EPA per Worksheet #6 of the QAPP.

7.1 Implementation of Field-Based Approaches to Assess In Situ NAPL Distribution

The field-based approaches will incorporate technologies selected from the desk-top evaluation to measure the presence of NAPL in situ. Specifically, sub-tasks anticipated to be performed are as follows:

1. Field-based approaches to assess NAPL distribution in native sediments in the Canal in concert with characterization of sediment texture and geotechnical parameters (e.g., CPT) at all testing locations;
2. Collection of undisturbed sediment cores for confirmatory laboratory analysis to assess the NAPL distribution in native sediments of the Canal from a sub-set of the sampling locations;
3. Collection of undisturbed sediment cores for performance of laboratory mobility testing from the areas of highest observed NAPL saturation based upon field methods; and
4. Collection of groundwater and NAPL samples from the native sediment.

A barge will be employed to access sampling locations. The field evaluation method(s) selected from the desktop evaluation will be employed at each location, and the sub-tasks will be completed as necessary for a given testing location. The sub-tasks will be discussed in the following sections.

The geospatial location of the sampling locations will be recorded using mapping-grade GPS as described in SOP 100.

QAPP Worksheet #18 will provide a comprehensive listing of the sampling locations, nomenclature, and analytical program for this task once determined. QAPP Worksheet #19 provides information relating to appropriate sample container, sample volume, preservation, and holding time requirements for the standard analytical tasks for NAPL and groundwater. QAPP Worksheet #20 summarizes the field QA/QC sample requirements for this task. Frequency of field QC samples will be added in a subsequent revision of the QAPP.

7.1.1 Field-Based NAPL Distribution Assessment

The Tar-specific Green Optical Screening Tool (TarGOST®) (or similar, as selected in the desktop study) will be used to assess NAPL distribution in the field. The TarGOST® is a modification of the Ultraviolet (UV) Optical Screening Tool (UVOST®) and is a laser-induced fluorescence screening tool designed to detect NAPL through sensing the fluorescence of polycyclic aromatic hydrocarbons (PAHs) found in NAPLs. The TarGOST® system is a continuous measurement fluorometer which is coupled via fiber optics to a probe that is advanced into the subsurface such that the operator can evaluate NAPL distribution in situ in real-time. Cut sheets and the SOP for the selected technologies will be developed and provided prior to field deployment. The TarGOST® will be advanced in concert with a screening tool for sediment texture and geotechnical parameters (e.g., CPT). Sediment cores will be collected at select locations immediately adjacent to the TarGOST® deployment to verify and calibrate results, as described below in Section 7.1.2.

7.1.2 Collection of Undisturbed Sediment Cores for Laboratory Analysis

Undisturbed sediment cores are needed to evaluate the NAPL distribution and to assess the NAPL mobility. It is anticipated that sediment cores will be collected using a Shelby Tube or acetate liner collection apparatus to be advanced by non-vibratory method, though this methodology may be modified based on results of the desktop evaluation. Methods for sediment core collection will be specified in a forthcoming SOP.

For the NAPL distribution assessment, the coring device will be advanced to capture the profile of observed TarGOST® readings above background, which is anticipated to be approximately 10 ft of material below the soft sediments/native sediments interface. The actual length of core collected will depend upon the TarGOST® readings and may be more or less than 10 ft. A subset of these collected cores will be used to assess the NAPL mobility using the material below the soft sediments/native sediments interface in the zone of highest observed TarGOST®

response. If necessary, an additional undisturbed sediment core will be collected for the NAPL mobility assessment to minimize sample disturbance prior to testing.

For both the NAPL distribution and mobility assessment, the collected sediment cores will be preserved using a method that minimizes sample disturbance and will be sent to a laboratory for assessment.

Laboratory analytical methods applied to the sediment cores are discussed in Sections 7.2.1 and 7.2.2.

7.1.3 Groundwater and NAPL Collection

Where possible, samples of NAPL and groundwater will be collected from the native sediments in the general vicinity of the sediment sampling area. Groundwater and NAPL samples will be collected by advancing a temporary well into the native sediments and allowing sufficient media to collect inside the screen prior to sampling. Methods for temporary well advancement and sampling will be specified in a forthcoming SOP. The collected NAPL and groundwater samples will be analyzed for density (ASTM D1217), viscosity (ASTM D445), and interfacial tension (ASTM D971) at three different temperatures. The collected groundwater and NAPL samples will also be analyzed for chemical composition (Target Compound List volatile organic compounds [TCL VOCs] via EPA Method 8260B, TCL semi-volatile organic compounds [SVOCs] via EPA Method 8270C, and Target Analyte List [TAL] metals via EPA 6010C/6020A).

7.1.4 Sample Locations

Results of the desktop evaluation will be used to focus the application of field-based approaches to locations which are anticipated to have the highest likelihood of vertical upward NAPL migration and/or the highest anticipated NAPL saturation. Within the focused areas, a series of smaller, initial target areas will be defined by the existing 3-D data distribution as initial areas of deployment to assess the efficacy of field-based approaches and laboratory analysis programs. Following the successful completion of the initial deployment, the approach will be expanded to the larger objective of delineating and/or defining the areas of migrating NAPL below the Canal for remedy implementation.

7.2 NAPL Distribution and Laboratory Mobility Testing (Specialty Testing Laboratory)

The goal of the laboratory analysis of undisturbed sediment cores is to understand (i) the vertical seepage velocity, among other factors, that is necessary to cause upward migration of the NAPL within the native sediments, and (ii) the confining pressure needed to impede this migration if it exists. The scope of work for the laboratory mobility testing includes (i) characterization analyses of the collected sediment core, NAPL, and groundwater samples, and (ii) empirical assessment of potential vertical NAPL mobility.

7.2.1 Laboratory NAPL Distribution Analysis

The undisturbed sediment core samples collected for NAPL distribution assessment will be analyzed using established laboratory-based NAPL mobility assessment methods. These may include but are not limited to the following:

- Pore fluid saturation via Dean-Stark (API RP40) at a set vertical spacing, which will be collocated with field-based assessments to confirm the NAPL vertical distribution from the field readings;
- Centrifuge and/or water flood of sediment samples to assess NAPL residual saturation and mobility potential (proprietary method);
- Drainage capillary pressure data (i.e., water retention curves) to understand the soil matrix and to develop the parameters to understand pore entry pressures (ASTM D6836);
- Potential photography of the core under white and UV light to provide an understanding of the vertical NAPL distribution and aid in defining vertical depths for further mobility assessment (ASTM D5079); and
- Geotechnical parameters to confirm the field-based approach for soil/sediment texture/geotechnical observations (Sieve by ASTM D4222, intrinsic permeability to Product (NAPL) by API RP40, intrinsic permeability/hydraulic conductivity by API RP40, Atterberg Limits by ASTM D4318).

7.2.2 Laboratory Mobility Testing

As noted, a sub-set of the undisturbed sediment cores will be used for laboratory mobility testing. A laboratory mobility testing method that mimics natural conditions will be used to assess the mobility of the NAPL within the sediments. The laboratory mobility testing method will be developed as part of the desktop study under this work element. The goal of the laboratory-scale work is to understand, among other factors, the vertical seepage velocity and hydraulic head gradients that are necessary to cause upward migration of the NAPL within the native sediments.

Various pressure gradients and seepage velocities will be tested to evaluate vertical migration potential under in situ conditions. If necessary, additional NAPL will be added to the sample to understand what NAPL saturation threshold is necessary at given velocities to cause vertical migration. As part of this testing, a sensitivity analysis will be completed to understand which parameters most strongly control mobility.

SECTION 8

DOCUMENTATION, SAMPLE PACKING, AND SHIPPING

8.1 Field Documentation

Field visits and sample collection programs will be documented using a combination of field log books and specific field log forms as described in SOP 101.

The log book(s) will provide a comprehensive overview of all Gowanus Canal activities throughout the PD work; the level of detail of documentation within each log book entry will depend upon the duration of an individual visit and the applicability of field forms to the tasks performed. Dedicated log books will be used for each type of field instrument.

8.2 Sample Nomenclature

Sample nomenclature and duplicate nomenclature will be developed prior to collection of field samples for inclusion in Worksheet #18 of the QAPP.

8.3 Sample Packing and Shipping

8.3.1 Sample Custody

Sample collection and sample custody procedures are designed so that field custody of samples is maintained and documented. These procedures provide identification and documentation of the sampling event and the sample chain of custody from shipment of sample containers, through sample collection, to receipt of the sample by the subcontracted laboratory. When used in conjunction with the laboratory's custody procedures and the sample bottle documentation, these data establish full legal custody and allow complete tracking of a sample from preparation and receipt of sample bottleware to sample collection, preservation, and shipping through laboratory receipt, sample analysis and data validation. The chain of custody is defined as the sequence of persons who have the item in custody.

Field custody procedures are described below and in SOP 101. Sample collection procedures concerning sample identification and documentation, field log book, sample containers, sample packing, and sample shipping are described.

8.3.2 Chain of Custody

The field chain of custody Record is used to record the custody of all samples or other physical evidence collected and maintained. This form shall not be used to document the collection of duplicate samples. Duplicate sample information will be documented in field log books. The chain of custody Record also serves as a sample logging mechanism for the analytical laboratories’ sample custodian.

The following information must be supplied in the indicated spaces in detail to complete the field chain of custody Record:

- The project number;
- The project name;
- The signatures of all samplers and/or the sampling team leader in the designated signature block;
- The sampling station number, date, and time of sample collection, grab or composite sample designation, and sample preservation type must be included on each line (each line shall contain only those samples collected at a specific location);
- The sampling team leader's name should be recorded in the right or left margin of the chain of custody Record when samples collected by more than one sampling team are included on the same form;
- The total number of sample containers must be listed in the indicated space for each sample. The total number of individual containers must also be listed for each type of analysis under the indicated media or miscellaneous columns. Note that it is impossible to have more than one media type per sample;
- The field investigator and subsequent transferee(s) must document the transfer of the samples listed on the chain of custody in the spaces provided at the bottom of the form. Both the person relinquishing the samples and the person receiving them must sign the form; the date and time that this occurred must be documented in the proper space on the form. Usually, the last person receiving the samples or evidence should be a laboratory sample custodian; and
- The remarks column at the bottom of the form is used to record air bill numbers or registered or certified mail serial numbers.

Once the Record is completed, it becomes an accountable document and must be maintained in the project file. The suitability of any other form for chain of custody should be evaluated upon its inclusion of all of the above information in a legible format.

8.3.3 Sample Packing and Shipping

Per SOP 102, samples are packed for shipping in watertight packaging within ice chests and coolers or similar containers. Depending upon container type, the sample containers may be individually sealed in Zip-loc® or other similar plastic bags, prior to packing them in the cooler with bubble wrap or Styrofoam packing. Wet ice will be bagged in zipper-top plastic bags and placed with the samples in the cooler to maintain the samples at a temperature of ≤6°C during shipping.

The chain of custody Record identifies the samples is signed as "relinquished" by the principal sampler or responsible party. This Record is sealed in a waterproof plastic bag and is placed inside the cooler, typically by taping the bag to the inside lid of the cooler. A duplicate copy of the chain of custody Record will be maintained by the Field Team Leader.

Following packing, the cooler lid is sealed with packing tape. A custody seal is signed, dated, and affixed from the cooler lid to the cooler body and is additionally covered with clear tape. This ensures that tampering with the cooler contents will be immediately evident.

The sample coolers will be shipped by overnight express courier to the laboratory. A copy of the shipping invoice is retained by the Field Team Leader and becomes part of the sample custody documentation.

The Field Team Leader should contact the laboratory ahead of time to inform laboratory personnel of the number of samples, analytes, courier service, and other pertinent information to ensure the integrity of sample results. All shipping procedures will comply with Department of Transportation regulations (49 CFR 173 to 177) and the International Air Transportation Association.

SECTION 9

REFERENCES

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Geosyntec Consultants, January 2014. *"Pre-Design Work Plan, Gowanus Canal."*

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ATTACHMENT B

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE NO. 100
RECORDING STATION LOCATION POSITION WITH A GPS

SECTION 1 INTRODUCTION

1.1 Objective

The objective of this standard operating procedure (SOP) is to establish standard procedures for recording sample location position with a global positioning system (GPS). Recording the location of field acquired data is essential to understanding contaminant distribution and necessary if returning to the location of collection is necessary during future sampling activities.

This SOP provides basic steps to guide the process of collecting, editing, and reporting accurate spatial data using Global Positioning System (GPS) technology. The intended audience of this document includes all personnel involved in planning and conducting GPS surveys, as well as processing and reporting GPS data sets. This SOP is not intended as a detailed user manual for specific brands of GPS receivers, operating systems or software applications.

1.2 GPS Receiver Types

There are three classes of GPS receivers:

- Recreational "hand-held" receivers: for basic navigation; accurate to within 15 meters with a 95% confidence.
- Mapping-grade receivers: for storing mappable features; accurate in the 1 to 5 meter range; allow for post-collection differential correction.
- Geodetic-grade receivers: for applications that require extremely high accuracy, often to less than a centimeter.

The project-specific needs will determine the type of GPS receiver that is required to be used. A geodetic-grade receiver is not covered in this SOP, as it use would be limited to a surveyor specifically trained and subcontracted to the project for this purpose. Use of the hand-held receiver and mapping receiver are covered; however, the specific unit's owner's manual should additionally be consulted. Generally, fixed locations, such as soil and sediment samples, will be captured using a mapping-grade GPS and mobile resources, such as general areas of surface water collection or biota surveys, will be captured using a hand-held GPS.

1.3 Equipment

- GPS receiver and antenna
- GPS owner's manual

- Writing tools (pencils, Sharpie®)
- Field log book
- Spare batteries and/or battery charger
- Compass
- Tape measure

SECTION 2 PLANNING AND IMPLEMENTING A GPS SURVEY

The following sections outline the basic steps involved in systematic planning and conducting a GPS survey. In order to complete a successful GPS survey, several steps must be taken prior to using the receiver in the field. These steps will apply to the use of any of the various GPS receivers.

Field teams are encouraged to ensure that personnel are cross-trained to perform GPS coordination activities. Alternatively, field team may consider appointing and training interested staff members to serve as GPS coordinators. Most of the steps in the pre-survey and post-survey process will be conducted in conjunction with, or entirely by, the GPS coordinator. Equipment may be on loan to those employees who have been trained on the use of the GPS receiver. Those who require training or feel that retraining is necessary must notify the GPS coordinator well in advance of a proposed GPS survey so arrangements can be made for training.

2.1 Preplanning Activities

The Field Team Leader should develop the following planning items in cooperation with the GPS coordinator.

1. **Define Objectives of the Survey**

   It is important to initially establish the ultimate objectives of a GPS survey, including Data Quality Objectives (DQOs). Recognition of these objectives early in the project planning process will help to focus the rest of the planning phase. The accuracy requirements for the positional data must be defined and should be consistent with available program guidance on positional accuracy. In the absence of published program guidance on positional accuracy tiers to meet specific program needs, the following Interim Quality Categories provide benchmarks for establishing quality controls based on the intended use. Data collections for Category I use would dictate more stringent quality controls and potentially higher accuracies than Category IV use.

   Category I: For enforcement, litigation, direct support of rules & regulations, projects of national significance and highly influential scientific assessment

Category II: Development of rules & regulations and influential scientific information

Category III: Validation, general applications and feasibility studies

Category IV: Screening, exploratory and pure knowledge

From the discussion above, some distinct survey objectives may include:

- Registration of remotely sensed photography or imagery with ground control locations to support enforcement actions.
- Evaluation of locational data quality of existing data to validate survey maps, and
- Collection of new data following precise coordinates in a monitoring plan to support rule development.

NOTE: On a case-by-case basis, the user should consider the impact of various factors when determining the appropriate QA Category. These factors include, but may not be limited to:

- National Geospatial Data Policy (NGDP) Accuracy Tiers
- Dwell Time
- Number of Monuments, etc.
- QA categorization of Dilution of Precision (DOP) is provided as a suggestion/example below - section (7) Equipment Testing and Logistics.

2. Define Project Area

This step is designed to establish the overall project area and define the limits of the survey. Maps and/or aerial photos should be utilized extensively to familiarize the crew with the area prior to the actual field work. For identifying the study area and surrounding environment, 7.5-minute topographic maps are ideal. For locating particular sites by address, a local street map will be required. A complete understanding of the transportation network in the project area will also enable the field crew to maximize the effectiveness of their field time. Much of this information may already be available in digital form and may be used directly in conjunction with GPS site planning as well as validating the capture of the GPS locations.

3. Determine Observation Window and Schedule of Operations

This step involves determining the precise window of satellite availability and scheduling accordingly. With approximately 31 GPS satellites and 9 GLONASS satellites available for use, satellite links generally are restricted for very short periods of time (usually less than 40 minutes in a continuous block of time and less than 1 hour during a 12-hour time period) during the day, in open environments. However, in cities with many nearby tall buildings, GPS signals may be difficult to receive. Updated satellite configuration and orbit information can be accessed via the Internet. "Trimble Planning Software" from Trimble Navigation is an easy-to-use software program which provides information critical to the various components of planning a GPS survey: satellite availability, elevations, azimuths, and Geometric Dilution of Precision (GDOP) calculations. However, there are many other easy to use software programs to assist users in updating. Some sites may be specifically designed for desktop, laptop, or handheld devices. Site sources and URLs may change frequently, therefore, users are encouraged to find the best site for their hardware and purpose, and ensure that the source of update is recorded in a notebook. For differential corrections against a base station, the rover must "see" the same satellites as the base. Accuracy is heavily dependent upon the amount of observation time and number of observations taken at each point. It is generally agreed that observation time can be reduced by increasing the quality of observation, i.e., observing a maximum number of satellites during viewing periods.

NOTE: "Trimble Planning Software" [2.74 (.zip file)] can be downloaded from

http://www.trimble.com/planningsoftware_ts.asp

Download and install "Installation Program for Planning" software. Download the GPS satellite almanac from Trimble GPS Data Resources. If you are in an area with obstructions, select File-Station and click obstacles to enter the elevation and azimuth to define the obstruction. You should then be able to display the DOP relating to that location to better plan your survey. If you are occupying multiple stations at the same time, use File - Multistation in addition to defining the information for each station.

4. Establish Control Configuration

For high accuracy work, generally sub-meter range, known control points and/or benchmarks should be located for both horizontal and vertical control. This is usually accomplished by researching the records of various federal, state, and local agencies such as the National Geodetic Survey (NGS) or the state geodetic survey. It is advisable to have, if possible, at least two control points each for both vertical and horizontal positions so that there is a double check for all control locations. Vertical accuracy is typically half of the horizontal accuracy. Any additional control points may be done by using centimeter GPS. NGS benchmark information can be obtained at http://www.ngs.noaa.gov. NOTE: When high accuracy readings, such as sub-meter range, are required for a project, such as a Category I, the user must have substantial technical know-how, perhaps high-end GPS hardware and definitely advance preparation. For the Category I project types, users may consider contracting for professional land surveyor services. Data obtained by non-certified personnel may be inadmissible in litigation. Project Officers are encouraged to contact their local Office of General Council for consultation regarding concerns of admissibility.

It is important that the reference datum within which the monument is located be defined. For horizontal coordinates, the North American Datum of 1927 (NAD 27) or the newer Datum of 1983 (NAD 83) will be specified. For vertical control coordinates, the National Geodetic Vertical Datum of 1929 (NGVD 29) or the new North American Vertical Datum of 1988 (NAVD 88) will be referenced. If the NGS has redefined the benchmark coordinates to correspond to the newer datums, coordinates will be available for both datums. In translating GPS elevations to vertical elevations, the geoid used should be identified.

5. Select Survey Locations

Obtain a list of the facilities or features targeted for data collection. One suggested approach is to organize the site lists alphabetically by city and alphabetically by street name within each city as well as by zip code. This approach will facilitate initial route planning to visit each survey location and serve as a master list. If possible, plot the general location on a field map and highlight a local street map to serve as a general navigation aid. Similarly, project personnel should also plot potential base stations to serve as control points on a 7.5-minute topographic map and local street map. The survey points/areas should have continuous and direct line-of-site to the path of the satellites in the sky. If the survey point to be obtained is located on private property, care should be taken to pursue appropriate notification and access protocol. This includes preparation of a letter of introduction and formal contact with the property owner/manager.

6. Co-ordinate Pre-Survey Plans

The Field Team Leader should contact the GPS Coordinator to identify and discuss the following items prior the GPS survey:

- **Objectives.** Objectives of the survey, particularly Data Quality Objectives since DQOs will highlight required data accuracies (sub-meter, 1-5 meters) and in turn, dictate the type of equipment needed. Identification. Identification of the numbers of features to be mapped and time allotted for the survey.
- **Availability.** The availability of the GPS equipment for the required dates. Features. What features will be mapped, sample point location identification, and how they should be represented (points, lines, areas).

- **Checklist.** A checklist of each feature to be mapped so that none will be overlooked in the field.
- **Site Maps.** Site maps for determining survey location with the identification features to be mapped and mapping sequence.
- **Reconnaissance.** Determine the presence of any obstructions to satellite signals such as buildings or tree canopies.
- **Data Format and Storage.** Data capture requirements and data format to facilitate postprocessing at the conclusion of the survey.

7. **Equipment Testing and Logistics**

Action items for equipment testing and logistics include determination of equipment availability (laptop PDA, GPS units, and transport vehicle), checking equipment for necessary repair and maintenance (batteries charged in PDA and GPS unit, laptop or PDA loaded with necessary software and map data), and ensuring that the receiver is functioning properly. Operation manuals provided by the vendor should be referenced to complete system checks on the equipment.

Modern GPS units contain many settings that can serve as quality checks during data acquisition. For instance, a minimum number of visible satellites can be specified for data acquisition. The unit will provide a warning signal if less than the minimum specified are available. Four satellites in view are the minimum required, but additional satellites can provide the receiver with stronger signals to select from and perhaps better geometry for calculation. GPS receivers can also calculate a DOP value for horizontal (HDOP), for time (TDOP) and general position (PDOP). Position Dilution of Precision (PDOP) is most often referenced with lower values leading to more accurate measures. PDOP values of 6 or less are generally acceptable and limits on PDOP can be programmed into the unit or software that interfaces with the receiver. See table titled DOP Values in Relation to Data Quality Categories below:

DOP Values in Relation to Quality Categories

DOP Value	Rating	Description	Suggested for Quality Category
1	Ideal	Highest possible confidence level.	I
2-3	Excellent	Meets all but most demanding	I or II

		needs.	
4-6	Good	Appropriate for most needs.	II, III, or IV
7-8	Moderate	For less demanding uses. Positional measurements could be used for calculations, but the fix quality could still be improved. A more open view of the sky is recommended.	IV
9-20	Fair	Low confidence level. Positional measurements should be discarded or used only to indicate a very rough estimate of the current location.	Not recommended
>20	Poor	Very low confidence level. Measurements are inaccurate by as much as half a football field and should be discarded	Not recommended

2.2 <u>Survey Execution</u>

The actual GPS survey consists of:

1. **Establishing a Schedule of Operations**

   This step involves determining the window of satellite configuration availability and scheduling the GPS sessions. The schedule is dependent on the size of the crew, the level of accuracy desired, and the logistics of setup and travel between control points. Maximum data quality and collection efficiency can be obtained by arranging data collection periods to coincide with periods of 3-D or better satellite visibility.

2. **Pre-Survey: The Day Before**

   Charge all batteries, make note if GPS unit(s) can be charged through the automobile. Many GPS collection systems utilize a battery system which requires either 8-hour or overnight charging. Review the travel routes to survey sites and base stations, if required, and coordinate with local personnel. Review use of unfamiliar equipment and understanding of procedures.

3. **Pre-data Collection: Establishing a Base Control Station(s)**

   The type of survey will dictate if any base control stations in the field are required. If required and the location(s) is not secure or if the data collection period is particularly long, part of the survey crew may be required to remain at the site. Logistical considerations will need to be scheduled, i.e., shut down periods for downloading files, changing battery packs, and when to terminate collection. Once a setup at a base station begins, the GPS units will need to be initialized. Depending upon the location and familiarity with equipment, this activity can take anywhere from a few minutes to a couple of hours.

4. **Data Collection: Performing the GPS Survey**

   The crew must warm up, check, and program the receiver for proper operation. Most vendors currently recommend collecting fixes for discrete point data for a period of 3-5 minutes, at 1-or 2-second intervals. Vendor documentation should be consulted for the recommended time on station and sample interval to obtain the most accurate results. Depending on the unit being utilized, sufficient battery power must be available. For high accuracy work, the receiving antenna should be leveled on a tripod and centered exactly over the control point location. Log sheets containing critical information on position, weather, timing, height of instrument, and local coordinates must be maintained. Once the session is completed, the receiving equipment must be disassembled and stored. The log and tape files should then be documented and saved. If the survey to be performed will span numerous days, it is likely that the data will be transferred from the GPS to a laptop PC with some regularity. Data from the base station as well as the roving unit will need to be collected with equal frequency.

2.3 <u>Data Assessment, Processing and Validation</u>

Post-processing should be conducted after returning from the field. Tools for post-processing are more easily used and controlled in an office environment. The common steps in post-processing are transferring the data from the field to office workstations, conducting the initial stages of processing, computation of the solutions for critical factors, data conversion for use in a GIS, and the final documentation and reporting. Each of these stages is discussed in detail below. Data assessment and validation should integrate in each stage.

1. **Data Transfer**

   There are currently two common methods of collecting data in the field: using a GPS unit with a data logger or using a GPS unit attached to a laptop/notebook/PDA computer. With the latter method some users subsequently perform all processing directly on the same device. More commonly, data are transferred into a computer. This consists of reading the raw data from the GPS unit into a structured data base for processing. As with any computer data, backup copies should be made immediately. Validation should consist of reviewing the contents of the data logger or computer file against the survey plan and field notes to ensure that the data transfer has occurred properly and that file and directory names are adequate to link the data to specific field operations or features.

2. Data Assessment and Initial Processing

The electronic GPS data stream may not be immediately useable. It normally consists of satellite navigation messages, phase measurements, user input field data and other information that must be transferred to various files for processing before computations can be accomplished. Depending upon the hardware and software vendor, many of these operations are transparent to the user.

In some instances, depending on the type of maintenance and upgrades that are going on to the NAVSTAR constellation at the time of the survey, utilization of the actual ephemeris rather than the ephemeris projected prior to the survey date may improve solution accuracy. Actual ephemerides are available 2 weeks after a given survey date.

In the data screening and editing, there are at least three considerations that might be taken in editing. Outlier position data can be removed from a data file. This editing should be guided by establishing an absolute deviation threshold, using the mean coordinate as a reference. The threshold criteria might be varied to determine the sensitivity of the solutions to this editing. Data points collected immediately after a break in the data stream, such as in the event of masking, should be edited out because these positions will be less reliable.

The majority of processing operations are typically performed "automatically" by the application software. Occasionally, the scientist (or operator) may need to override automatic computer operations. In these instances, scientist (or operator) should document the judgments made and identify the manual operations in the appropriate notebook.

3. Computation

This component uses the preprocessed data to compute the network of sites and give a full solution showing geographical coordinates (latitude, longitude and ellipsoidal height), distances of the vectors between each pair of sites in the network, and several assessments of accuracy of the various transformations and residuals of critical computations. This is usually accomplished by the vendor post-processing software and may be transparent to the user.

4. Data Conversion to GIS

Data conversion is accomplished by use of data export utilities provided by the GPS vendor. These utilities should accompany the data processing software packaged with the GPS equipment. Example formats are: ArcView, ArcGIS, dBase, ASCII, MapInfo, AutoCAD, etc. Before exporting, ensure that the correct coordinate system and datums are chosen. The default coordinate system should be the Geographic Coordinate System which provides unprojected latitude/longitude values. The default datum is NAD83 for horizontal coordinates and NAVD88 for vertical coordinates. Note that GPS units initially capture data using the WGS84 horizontal datum but can be usually converted to the NAD83 datum during the data export process. Care should be taken in reporting the proper datum upon completion of the conversion process.

SECTION 3 TYPICAL RECORDING PROCEDURES

This section provides the typical procedures to be followed when recording the location of field acquired data.

1. Turn GPS on outside in an open area. Wait for antenna to receive satellite signals. Continue to wait until a minimum number of satellites are acquired to achieve an appropriate PDOP (see Section 2.1 for ranges).
2. Move the GPS to the location of the sample. Try to remain still or if on a boat ensure that the boat is still. Press the appropriate key strokes to mark a waypoint (see Owner's Manual).
3. Record the waypoint name in the field logbook. It is good practice to also record the coordinates (latitude and longitude). If the GPS is capable of downloading waypoint names and associated coordinates to a file readable by PC, then recording the coordinates in the logbook may be skipped.
4. If the GPS cannot be placed on the location of the sample record the distance and compass direction to the location as an "offset". This information should be recorded in the field logbook and used to correct the position at a later time.
5. At the end of each day, if equipped, the data file should be downloaded to a PC and transmitted to the project data manager for incorporation into the project geographic information system (GIS).
6. If the coordinates are recorded by hand in the field log book, they should be entered into a spreadsheet with the sample location name and submitted to the project data manager for incorporation into the project GIS.

STANDARD OPERATING PROCEDURE NO. 101 FIELD DOCUMENTATION, SAMPLE DESIGNATION, CUSTODY AND HANDLING PROCEDURES

SECTION 1 INTRODUCTION

The integrity of each sample from the time of collection to the point of data reporting must be maintained throughout the study. Proper record keeping will be implemented in the field to allow samples to be traced from collection to final disposition. All information relevant to field operations must be properly documented to ensure that activities are accounted for and can be reconstructed from written records. Several types of logbooks will be used for this purpose and should be consistently used by field crews (e.g., field logbooks, field data sheets). This document describes the procedures to be followed for field documentation, sample designation, handling, and custody.

1.1 Referenced Documents and SOPs

- Health and Safety Plan (HASP),
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)
- SOP 102 Procedure to Prepare Samples for Shipment

SECTION 2 FIELD DOCUMENTATION

2.1 Field Documentation

During field sampling events, field logbooks and field data sheets are used to record all daily field activities. The purpose of the field logbook is to document events that occur and record data measured in the field.

Data entry will be made in a bound, waterproof field logbook with consecutively numbered pages using indelible ink for each sampling event; all entries will be signed and dated and no erasures will be made. All corrections should consist of a single line-out deletion, followed by the sampler's initials and the date. The sampler will sign and date the last page at the end of each day, and a line will be drawn through the remainder of the page.

The project name, site name and location, and dates of sampling activity should be written on the cover of the field logbook. If more than one logbook is used during a single sampling event, then the upper right hand corner of the logbook will be annotated (e.g., 1 of 2, 2 of 2) to indicate the number of logbooks used during the field event. Alternatively, multiple logbooks could be used for different sampling activities (e.g., one logbook for surface water sampling and one for groundwater sampling). When multiple logbooks are used for a single sampling activity (e.g., 2 or more sampling teams operating simultaneously during a single surface water sampling event) logbooks should be annotated alphabetically to indicate which of those books is the primary, secondary, etc. logbook for that sampling activity, followed by the number of the logbook. For example if surface water sampling requires 3 teams and each have a logbook to record daily activity over the sampling event then the primary book will be labeled "Log Book A-1" and the others as "B-1" and "C-1." When only one team is on site, they will use the primary (A) logbook. Field logbooks will be stored in a secure manner when not in use in the field.

In addition to the field logbook, supplementary field data forms may be used during a field sampling event (e.g., Station/Sample Log, Groundwater Monitoring Form, Sediment Core Profile Form) to record the relevant sample information collected during a sampling event. At a minimum, the sampler will record the following information daily in the field logbook or on a field sampling form, as applicable:

- Project name, project location, and project number
- Project start date and end date
- Date and time of entry (24-hour clock)
- Time and duration of daily sampling activities
- Weather conditions at the beginning of the field work and any changes that occur throughout the day, including the approximate time of the change
- Name of person making entries and other field personnel, including the times that they are present
- Onsite visitors, if any, including the times that they are present
- The name, agency, and telephone number of any field contacts
- The sample number and analysis code for each sample to be submitted for laboratory analysis
- All field measurements made (unless specific data sheets are available for this purpose), including the time that the measurement was collected
- The sampling location name, date, gear, water depth (if applicable), and sampling location coordinates
- Type of sample gear used (e.g., pump type or model, gill net mesh size, size of core barrel)
- The location and description of the work area, including sketches and map references, if appropriate
- Specific information on each type of sampling activity
- The sample type (i.e., groundwater, soil, surface sediment), and sample number

- Cross-references of numbers for duplicate samples
- A description of the sample (source and appearance, such as soil or sediment type, color, and odor)
- Log of photographs (number taken, photo number on roll or memory card, brief description of photo) taken at the sampling location, if any
- Variations, if any, from specified sampling protocols and reasons for deviation
- References to other logbooks used to record information (e.g., field data sheets, health and safety log).
- The signature of the person making the entry.

Monitoring or sampling equipment information, including installation information, any maintenance performed on each piece of equipment, calibration information, and other observations relating to the operation or condition of the equipment, will be recorded on field forms, in field logbooks, and/or in a separate field logbook maintained for a specific type of monitoring or sampling equipment. Upon completion of the field sampling event, the field team leader will be responsible for submitting all field logbooks and field data forms to the project data manager to be copied. Hard copy and an electronic copy shall be maintained in the project files.

SECTION 3 SAMPLE DESIGNATION AND HANDLING

3.1 <u>Sample Labels</u>

A self-adhesive, non-removable label will be affixed to each sample container and completed with an indelible marker prior to sample collection. Sample labels will contain the following information:

- Site name;
- project number;
- a unique sample identification number (see project-specific FSP for correct sample designation nomenclature);
- initials of sample collector(s);
- time and date collected;
- analysis required; and
- sample preservative (if applicable).

If samples are likely to contain high concentrations of VOCs or other analytes, the samples will be identified on the chain-of custody forms. Field duplicate or replicate samples will require special procedures for sample designation to ensure that they are submitted as blind samples to the laboratory. The well identification or sample location will not be included in the sample identification number and the collection time will be left blank but recorded in the field log book. The sample and corresponding field QC sample information will be documented in the field records.

3.2 Sample Handling

Each sample container will be sealed in a separate plastic bag following collection. Samples will then be stored in an insulated cooler containing ice packs or ice sealed in a plastic bag. If samples are not immediately shipped to the laboratory, they may be stored in a securerefrigerator/freezer and maintained at the proper temperature. Samples selected for laboratory analysis will be transferred to insulated coolers for overnight shipment to the laboratory. All samples shipped will be carefully checked against the chain-of-custody form (discussed below). Each cooler will be packed in a manner that will prevent damage to sample containers during shipment in accordance with SOP 102.

3.3 Sample Custody and Documentation

Chain-of-custody forms will be used to trace the possession and handling of all samples, from their collection, through analysis, until their final disposition. These forms will document the names of the relinquishing and receiving parties, the time and date of the transfer of custody, and the reason for the transfer of custody. One chain-of-custody form will accompany each cooler shipped to the laboratory. In the event that multiple coolers of samples are being sent to the same location, a unique, task specific, sample shipment group identifier and the number of coolers will be added to the top and special instructions portions of each chain-of-custody. The identifier will include the sample task (e.g., SW for surface water, SED for sediment), sample shipment group (SSG), date (year followed by day of year), and cooler destination (e.g., PITT for Test America Pittsburgh, NC for Test America North Canton). The chain-of-custody form will be placed in a sealed plastic bag inside the cooler. A custody seal will be placed on each cooler after packing and prior to shipment. For multiple cooler shipments, the sample shipment group identifier listed on the chain-of-custody will be written on the custody seal, as well as the cooler number designation (e.g., cooler 1 of 2, cooler 2 of 2). Shipping of samples to the laboratory will be accomplished by Federal Express or equivalent overnight service. Samples will remain in the custody of the sampling team until custody is relinquished to the courier service that will transfer the samples to the laboratory. Each sample shipment will be tracked via the courier weigh bill number to ensure that prompt delivery of the shipment to the laboratory has occurred.

Upon receipt by the laboratory sample custodian , the Sample Custodian will note on the form whether the custody seal is intact, the cooler temperature, the presence of air bubbles in any of the water samples submitted for VOC analysis, any damaged sample containers and/or discrepancies between the sample label and information on the form, and sign and date the form. A copy of the chain-of-custody form will then be transmitted to the Project Manager or their designate for their records.

STANDARD OPERATING PROCEDURE NO. 102
PROCEDURE TO PREPARE SAMPLES FOR SHIPMENT

SECTION 1 INTRODUCTION

1.1 Objective

The objective of this standard operating procedure (SOP) is to establish packaging and shipping requirements and guidelines for environmental sample shipping. Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)

1.3 Task-Specific Equipment

- Coolers with an appropriate return address taped to the inside lid
- Heavy-duty, large plastic garbage bags
- Plastic Zip-lock bags, small and large
- Writing tools (pencils, Sharpie®, etc.)
- Fiber tape
- Duct tape
- Packing peanuts (optional)
- Bubble wrap (optional for plastic sample containers; required for glass sample containers)
- Wet ice or dry ice (depending on sample requirements and availability)
- Chain-of-Custody seals
- Completed Chain-of-Custody record or CLP custody records if applicable
- Completed Bill of Lading

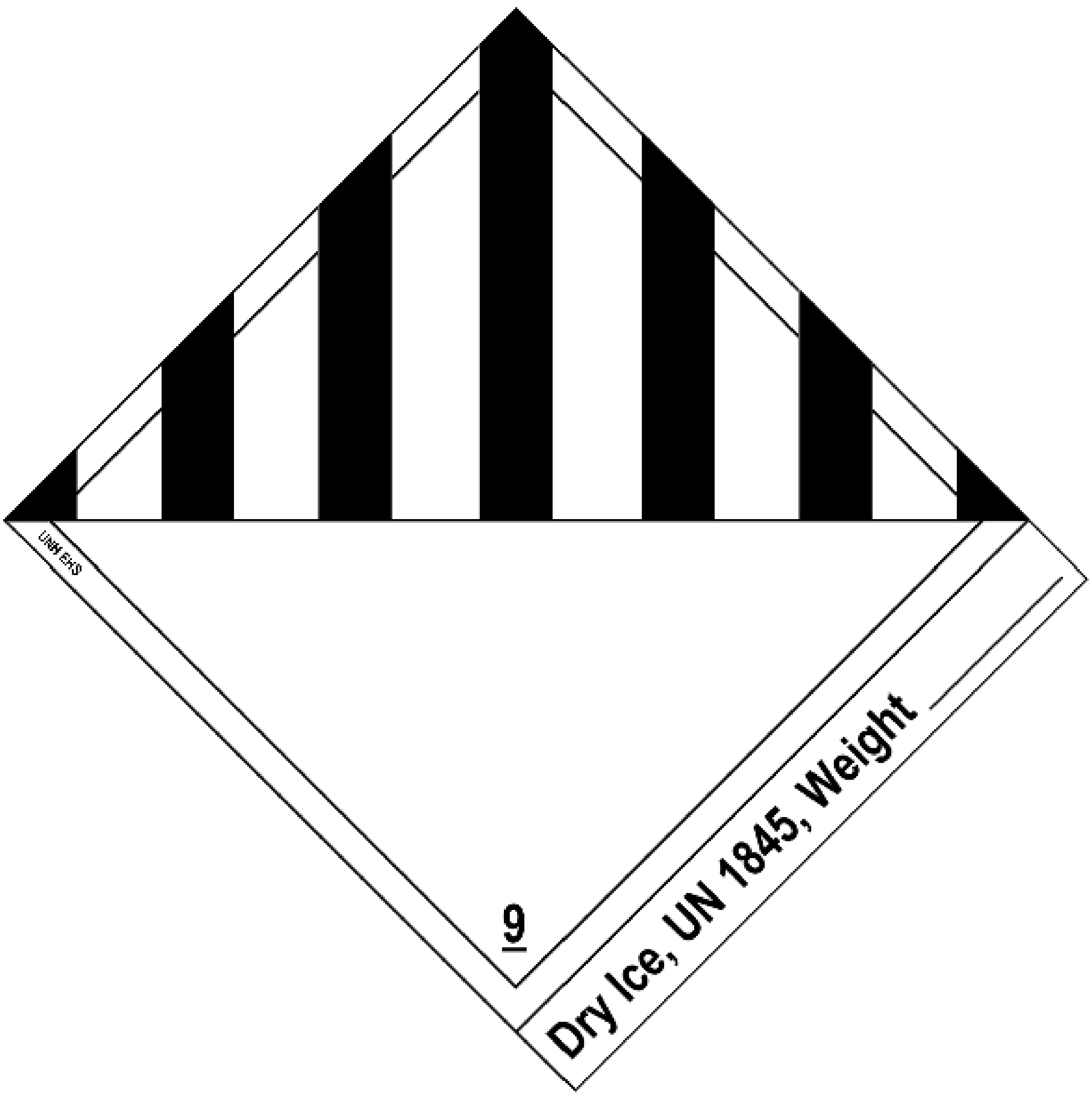
The term "Environmental Sample" refers to any sample that has less than reportable quantities of any hazardous constituents according to Department of Transportation (DOT) 49 CFR - Section 172.

SECTION 2 PROCEDURES

The following steps must be followed when packing for shipment by air:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug (inside and outside) with duct tape.
2. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly.
3. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Glass bottles will be wrapped in bubble wrap. All sample bottles and jars will be placed in the cooler vertically. Due to the strength properties of a glass container, there is much less chance for breakage when the container is packed vertically rather then horizontally.
4. Place two inches of bubble wrap or packing peanuts into the heavy-duty, large garbage bag in the cooler and then place the bottles and cans in the bag with sufficient space to allow for the addition of ice between the bottles, jars, and cans.
5. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place these ice bags on top of, or between, the samples. Place a temperature blank in the cooler. If necessary, any additional space in the cooler (after sufficient ice has been included) should be filled with more bubble wrap or packing peanuts to prevent the samples from shifting within the cooler during shipping.. Securely fasten the top of the large garbage bag with tape (preferably duct tape).
6. Place the completed Chain-of-Custody Record for the laboratory into a plastic zip-top bag, close the bag and tape it to the inner side of the cooler's lid, and then close the cooler.
7. Completed Chain-of-Custody seals are affixed to the top opposite sides of the cooler. Wrap clear tape over custody seals. Fiber tape shall be wrapped around the cooler opening and around the width of the cooler a minimum of two times half on the fiber tape so that the cooler cannot be opened without breaking the seal.
8. The shipping containers must be marked with FRAGILE, THIS END UP, and arrow labels, which indicate the proper upward position of the container. A label containing the name and address of the shipper shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted to be on the outside of the container used to transport environmental samples and shall not be used. The exception to this is for samples that are to be shipped frozen on dry ice. These sample containers must labeled with the proper dry ice label (see attached) with the quantity of dry ice indicated.

9. The sample coolers are typically shipped by overnight express courier to the laboratory. Securely attach the courier's shipping label with tracking number to the outside of the cooler. A copy of the shipping invoice is retained by the Site Manager and becomes part of the sample custody documentation.
10. The field manager should contact the laboratory ahead of time to inform laboratory personnel of the number of samples, analytes, courier service, and other pertinent information to ensure the integrity of sample results. All shipping procedures will comply with DOT regulations (49 CFR 173 to 177) and the International Air Transportation Association (IATA).



Dry ice label to be affixed to all coolers containing dry ice.

STANDARD OPERATING PROCEDURE NO. 103
DECONTAMINATION PROCEDURE FOR SAMPLING EQUIPMENT

SECTION 1 INTRODUCTION

This Standard Operating Procedure (SOP) was prepared to direct field personnel in the methods for decontamination of field equipment used in the investigation of sites with chemical Constituents of Potential Concern (COPCs).

1.1 Objective

The objective of equipment decontamination is to remove potential contaminants from a sampling device or item of field equipment prior to, between, and after collection of samples for laboratory analysis and limit personnel exposure to residual contamination that may be present on used field equipment.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)
- SOP 104 Management and Disposal of Investigative Derived Waste

1.3 Task-Specific Equipment

The following equipment may be utilized when decontaminating equipment. Site-specific conditions may warrant the use or deletion of items from this list.

- Alconox, liquinox or other non-phosphate concentrated laboratory grade soap;
- Distilled/deionized water from the analytical laboratory
- Pump sprayers
- 1-pint squeeze bottles
- Pesticide-grade acetone
- 10 percent nitric acid
- One (1) percent nitric acid
- Five large plastic wash basins (i.e., 24 inches by 30 inches by 6 inches deep)
- Coarse scrub brushes

- Small wire brushes
- Aluminum foil
- Polyethylene sheeting
- High pressure portable steam cleaner and power supply
- Personal protective equipment (PPE) as required by HASP

SECTION 2 PROCEDURES

2.1 General

The following procedures should be used for decontaminating field equipment. Procedures will vary with equipment used and potential contaminants present at the site.

2.2 Procedure for Non-Aqueous and Aqueous Sampling Equipment

Soil and sediment sampling equipment, such as grab samplers, split spoon samplers, dredges, shovels, augers, trowels, spoons, bowls, and spatulas will be cleaned using the following procedure. (New, unused core liners should be rinsed with site water at the sample location prior to deployment.) Larger sample equipment such as the box corer and devices which employ a sample liner will be decontaminated per Section 2.3. Aqueous sampling equipment is to be cleaned in the same manner, although if the aqueous samplers will be used to trace level mercury analysis, all materials must be decontaminated in the laboratory according to EPA Method 1669.

1. Place five wash basins in an established decontamination area that has a low permeability liner (e.g., polyethylene) and secondary containment. The decontamination area must be of sufficient size to allow placement of the five plastic wash basins in a line, and provide an air drying area for equipment. Decontamination aboard marine vessels will need to follow the same procedures; however, the use of five staged wash bins may not be feasible due to space issues.
2. Fill the first wash basin with potable tap water. Add sufficient soap powder or solution to cause suds to form in the basin. Do not use an excessive amount of the soap or rinsing the soap residue off the equipment will be difficult.
3. Using a clean coarse scrub brush, wash the sampling equipment in the soap solution in the first basin, removing all traces of visible dirt. Be sure to wash inside surfaces of equipment as well as the exterior surfaces. Allow excess soap to drain off the equipment when finished.

4. Rinse the equipment with tap water in the second basin, using a clean coarse scrub brush or pressure sprayer to aid in the rinse, if necessary.
5. If the equipment is being used to sample for metals, rinse the equipment with nitric acid in the third basin. A 10 percent solution is used on stainless steel equipment. A one percent solution is used on all other equipment. If no metals sampling is being performed, this step may be omitted.
6. Spray down the equipment in the third basin, using potable tap water. Collect rinsate for disposal per SOP 104.
7. Spray down the equipment in the fourth basin, using pesticide-grade acetone, if sampling for organic compounds is to be performed. Collect any excess acetone for disposal per SOP 104. If no samples for organic compounds are being collected, this step may be omitted.
8. Allow the equipment to completely air dry on clean polyethylene sheeting.
9. Rinse the equipment in the fifth basin, using distilled/deionized water received from the analytical laboratory.
10. Allow the equipment to completely air dry on clean polyethylene sheeting.
11. Reassemble equipment, if necessary, and wrap completely in clean, unused aluminum foil, shiny side out for transport. Only immediate re-use of equipment on the same day without wrapping in foil is acceptable.
12. Spent cleaning solutions shall be drummed for disposal along with any other contaminated fluids generated during the field investigation for disposal per SOP 104.
13. Record the decontamination procedure in the field logbook or on appropriate field form.

Note that if temperature or humidity conditions preclude air drying equipment, sufficient spares should be available so that no item of sampling equipment need be used more than once. Alternatively, the inability to air dry equipment completely prior to reuse should be noted in the field logbook. In this case, additional rinses with distilled/deionized water should be used and recorded.

2.3 Procedure for Large Heavy Equipment

Because heavy equipment pieces (e.g., ATVs, drill rigs) are much larger than sampling equipment and generally come in less direct contact with sampling aliquots, a modified decontamination procedure is appropriate. The following steps outline the decontamination protocol for heavy equipment:

1. Place plastic sheeting on the ground large enough to accommodate equipment to be decontaminated. A decontamination pad may be necessary. The wash pad may consist of

a bermed area lined with plastic sheeting with a sump at one corner. A sump pump should be used to remove water from the sump and transfer it to a drum.

2. Use a high-pressure portable steam cleaner to remove potentially contaminated material from the equipment.
3. Scrub equipment with detergent and water to clean soiled surfaces.
4. Thoroughly rinse all surfaces.

STANDARD OPERATING PROCEDURE NO. 104
MANAGEMENT AND DISPOSAL OF INVESTIGATION DERIVED WASTE

SECTION 1 INTRODUCTION

This Standard Operating Procedure (SOP) establishes protocols for testing, storage, and disposal of Investigative Derived Waste (IDW). Disposal of laboratory test equipment and supplies will be handled in accordance with the laboratory QAPP.

1.1 Objective

IDW generated during this RI/FS may include:

- Sediments
- Surface water
- Biological tissues
- Personal Protective Equipment (PPE)
- Disposable sampling equipment
- Spent decontamination liquids
- Plastic sheeting, containers, etc.

The management of these IDW will be conducted to limit exposure of site personnel to hazardous materials and to prevent introduction of contaminated materials to uncontaminated environmental media at the site.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)

SECTION 2 GENERAL MEDIA

All IDW identified as potentially contaminated with hazardous materials will be collected at the point of generation and later stored in a designated and clearly marked IDW management area. All containers/drums will also be clearly labeled to indicate the source of the IDW. The IDW storage area will be inspected daily to ensure that storage procedures are adequate to keep the

IDW isolated and contained. Potentially contaminated IDW will be identified based on its origin and olfactory and visual evidence (e.g., presence of NAPL). Laboratory testing will be required to determine the proper disposition of these IDW.

The volume of waste will be minimized whenever applicable. Soil, liquid, and personal PPE IDW will be segregated and separately containerized. The PPE and plastic sheeting will be disposed of as nonhazardous waste unless it has been grossly contaminated. Spent decontamination liquids will be containerized in drums and tested to determine the proper disposal method.

STANDARD OPERATING PROCEDURE NO. 105
PROCEDURE TO CONDUCT A TECHNICAL SYSTEM FIELD AUDIT

SECTION 1 INTRODUCTION

1.1 Objective

The objective of this standard operating procedure (SOP) is to establish standard procedure by which a technical field audit is performed. A technical audit is a systematic and objective examination of a program to determine whether the field activities used for the collection of environmental data comply with the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP) in order to meet the data quality objectives for the project. Technical audits may also be used as an investigative tool when problems are suspected. Technical audits will typically be announced but may be unannounced. The QAPP will be the basis for planning and conducting the technical audits.

The following types of technical field audits may occur:

- Readiness reviews are conducted before specific technical activities (e.g., sample collection, field work, and mobile lab analysis) are initiated to assess whether procedures, personnel, equipment, and facilities are ready for environmental data to be collected according the QAPP and FSP.
- Technical systems audits (TSAs) qualitatively document the degree to which the procedures and processes specified in the approved QAPP and FSP are being implemented.
- Surveillance is used to continuously or periodically assess the real-time implementation of an activity or activities to determine conformance to established procedures and protocols.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)

1.3 Authority

The authority and independence of auditors, and the limits on their authority, must be clearly defined in the Quality Management Plan (QMP) and the project-specific QAPP. Prior to an audit, it is important to establish whether the auditors have the authority to stop or suspend work if they observe conditions that present a clear danger to personnel health or safety or that adversely affect data quality. Auditors should have sufficient authority, access to programs and managers, and organization freedom to:

- Identify and document problems that affect quality;
- Identify and cite noteworthy practices that may be shared with others to improve the quality of their operations and products;
- Propose recommendations (if requested) for resolving problems that affect quality;
- Independently confirm implementation and effectiveness of solutions; and
- When problems are identified, provide documented assurance (if requested) to line management that further work performed will be monitored carefully until the deficiencies are suitably resolved.

Auditors may be accompanied by EPA personnel as determined by the responsible organization and the contracting officer. However, if accompanied by EPA personnel, clear definition of the EPA representative's role and responsibility during the technical field audit shall be established prior to the audit.

1.4 Qualification

Auditors must have established qualifications in order to conduct a field technical audit. Three standards of qualifications follow:

- The auditor(s) assigned to conduct a specific audit should possess (individually or collectively) adequate professional proficiency to audit. This proficiency includes both technical and auditing skills necessary for the audit (this proficiency may be established by using more than one auditor).
- The auditor(s) shall be free from personal and external barrier to independence, organizationally independent, and able to maintain an independent attitude and appearance. This standard applied such that the audit findings will be both objective and viewed as objective by knowledgeable third parties.
- The auditors should use due professional care in conducting the audit and in preparing related reports. Auditors should use sound professional judgment in determining the standards that are to be applied to the audit. Exercising due professional care means using sound judgment in establishing scope, selecting the methodology, and choosing the tests and procedures for the audit. The same sound judgment should be applied in conducting the audit and in reporting findings.

ISO 10011-2-1994 states: "Auditor candidates should have a minimum of four years full-time appropriate practical workplace experience (not including training), at least two years of which should have been in quality assurance activities."

SECTION 2 PROCEDURES

The following steps must be followed when preparing, implementing, and reporting the results from a field technical audit:

2.1 Pre-audit activities

1. Planning – prior to implementing a technical field audit decisions should be made regarding what specific aspects of the project to assess, what type of audit to perform, and when and how often to perform the audit within the context of the QMP and the project-specific QAPP.
2. Audits should be performed early in a project to identify and correct deficiencies. Discovery of deficiencies at the beginning of a project may eliminate the need for re-sampling and analysis later on.
3. Select the type of audit to be performed. The graded approach should be used to guide audit planning decisions and to achieve the desired information. This ensures that audit resources are used effectively and efficiently where they are needed most. The level of effort in a technical audit is determined by the level of complexity and detail of the quality assurance and quality control procedures described in the project QAPP.
4. Selection of the audit team once the type of audit has been determined. Most audit teams consist of two individuals, a lead auditor supported by a supporting team audit member. However, audits may be performed by one auditor depending on the size and scope of the audit. Technical audits may be performed by auditors from Geosyntec or by independent, outside auditors.
5. Planning for an audit is critical for a satisfactory assessment performance. Audits should be properly planned to achieve quality results. The auditor or audit team shall review all pertinent project-specific documents (QAPP, FSP, Work Plan) prior to the audit. Also the following decisions should be made prior to an audit:
   - The authority for the audit,
   - The purpose and scope of the audit,
   - The type of audit to be conducted,
   - The performance standards of the audit,
   - The expected audit report format,
   - Any requirement for conclusions, recommendations, and suggested corrective actions,
   - The confidentiality and dissemination of the audit results,

- The identification of the client,
- The expected budget for the audit, and
- The schedule for the audit and its documentation/report.

6. The on site project personnel should be contacted regarding the upcoming audit.
7. An audit plan may be prepared prior to the audit depending on the complexity and scope of the audit.
8. Special forms and checklists may also be prepared prior to the audit. The use of a project specific checklist is recommended and should be developed as dictated by the needs of the project. All checklists should provide the following information regardless of the format or other content:
   - Identification of the auditor(s)
   - The audit date, and
   - The audit site.

2.2 Audit activities

1. Audit protocol shall be observed throughout the course of an audit. Auditors shall remain calm and professional at all times, particularly during interviews. It is the responsibility of the auditor(s) to establish an atmosphere of trust and cooperation.
2. An opening meeting should be conducted once on site. This meeting should be attended by the auditor(s), and all site personnel responsible for environmental data collection. The lead auditor will brief the attendees regarding the purpose and schedule of the audit.
3. A site tour should be completed prior to the beginning of project personnel interviews or work observation.
4. Work observation and project personnel interviews will be performed. This will include the following at a minimum:
   - Observation of the completion of documentation practices
   - Observation of the collection of samples
   - Observation of the calibration of field instrumentation
   - Observation of the handling, packaging, storage, and shipment of samples.
   - Document review.
5. Compilation of objective evidence during the audit will be achieved in the form of audit notes, copies of notebook pages, logs, and completed checklists.

6. The auditor shall evaluate the findings and observations against the specification of the project documents.
7. A closing meeting will be held at the end of the audit to brief the key field project personnel with regard to the findings and observations from the audit. During this meeting, project personnel will have the opportunity to address the findings and observations.
8. A draft audit report is submitted to the project manager. The draft audit report will summarize the findings and observation from the audit referenced against the project specifications and data quality objectives.
9. A final report will be prepared by the auditor once comments have been received and corrective actions implemented based on the draft audit report. The final report will be submitted to the project manager and copies will be distributed as specified by the QAPP.
10. Once all of the corrective actions have been verified and documented, the audit will be documented as "closed" through the issuance of an audit close-out letter.